DOCUMENT RESUME

ED 170 528	CE 020 631

TITLE	Forestry Manual for Vocational Agriculture Instructors. 1976 Revision. Bulletin No. 7001.
INSTITUTION	Wisconsin Association of Vocational Agriculture Instructors, Madison.; Wisconsin State Dept. of Public Instruction, Madison. Div. of Instructional Services.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C.
PUB DATE	76
NOTE	161p.; Manual prepared by the Forestry Committee
EDRS PRICE	MF01/PC07 Plus Postage.
DESCRIPTORS	Botany; Conservation (Environment); *Forestry; *Forestry Occupations; Job Skills; *Laws; Learning Activities; *Lumber Industry; Secondary Education; Trees; *Vocational Agriculture; *Wildlife Management
IDENTIFIERS	Wisconsin

ABSTRACT

The ten chapters included in this forestry manual for vocational agriculture instructors are grouped into three parts. A course outline precedes part 1 and assists the teacher by providing performance objectives, major concepts to be developed, a subject matter outline, motivational ideas, suggested learning activities, and a list of resource materials. Part 1 covers basic forestry information and includes the first three chapters: (1) Wisconsin Forest History; (2) Man and the Forest Community; and (3) Forestry Careers and Opportunities. Part 2 contains chapters 4-9 on managing the forest: (4) Forest Botany; (5) Forestry Skills; (6) Growing Trees for the Planted Forest; (7) Tending the Forest; (8) Harvesting, Marketing and Processing Cut Forest Products; and (9) Multiple Uses of the Forest. Finally, part 3 presents the tenth chapter, on forestry laws and programs. A list of suggested learning activities follow the informational literature in each chapter. The following materials are appended: guidelines for planning field trips, suggested cost record sheets, a timber sales agreement, and a glossary of forestry and lumbering terms. (BM)

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FORESTRY MANUAL
FOR
VOCATIONAL AGRICULTURE INSTRUCTORS

1976 REVISION

BY

Forestry Committee
Wisconsin Association of Vocational Agriculture Instructors

in cooperation with the

Agricultural Education Staff
Wisconsin Department of Public Instruction

Wisconsin Department of Natural Resources

Wisconsin Department of Agriculture

Wisconsin Forest Industries

Trees for Tomorrow Inc.

U.S. Forest Service

Minnesota Department of Natural Resources

University of Wisconsin - Extension

University of Wisconsin - Stevens Point

U.S. DEPARTMENT OF HEALTH,
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Published by

Division of Instructional Services

Wisconsin Department of Instruction

Barbara Thompson, Ph.D., State Superintendent

Bulletin No. 7001

CE 020 631

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ACKNOWLEDGEMENTS

The committee directly involved in preparing this manual is grateful for the help received from many sources that made our work possible. We wish to acknowledge our indebtedness to the following agencies and organizations for their contributions in time and materials necessary to complete this publication.

Wisconsin Department of Public Instruction

Wisconsin Department of Natural Resources

Wisconsin Department of Agriculture

Wisconsin's Forest Industries

Trees For Tomorrow Inc.

Minnesota Department of Natural Resources

U. S. Forest Service

University of Wisconsin - Extension

College of Natural Resources, University of Wisconsin - Stevens Point

Employers Insurance of Wausau

The Committee:

Gary Beastrom, North Central Technical Institute, Wausau

Richard J. Ewers, Fort Atkinson High School

Wayne D. Ganser, Stevens Point Area High School, chairman

Ray C. Gibbs, D.C. Everest Senior High School, Schofield

Ben D. Hylkema, Wausau West High School

Hugo M. DeJong, Medford Senior High School

Luke F. Lang, Marathon High School

Thomas J. Mueller, Wausau East High School

Edwin R. Olson, Mosinee High School

F. J. Doering, Head Consultant, Agriculture Education - Wisconsin Department of Public Instruction

Arnold Cordes, Consultant, Agriculture Education - Wisconsin Department of Public Instruction

Consultant
William A. Sylvester, Forestry Specialist, University of Wisconsin - Extension, and Assistant Professor of Forestry, University of Wisconsin-Stevens Point

The activity which is the subject of this report was supported in whole or in part by the U.S. Office of Education, Department of Health, Education, and Welfare. However, the opinions expressed herein do not necessarily reflect the position or policy of the U.S. Office of Education, and no official endorsement by the U.S. Office of Education should be inferred.

FOREWORD

The management of our natural and renewable resources must receive the attention of all people. Our future depends on how well our society will understand and solve the problems involved. It is the duty of responsible educators to make certain that the concepts learned are accurate and represent true conservation principles.

Because the management of our resources cover such vast areas, and the problems are so complex, the group preparing this manual felt that it could assist educators and students in the study of basic concepts. If stimulation of youth to additional conservation inquiry results, the principal objective will have been attained.

This manual is intended to be used as a guide with a number of suggested activities. The instructor will select and modify those exercises and activities suited and adapted to his objectives and available facilities. This will permit the instructor to use his expertise for implementation and motivation.

COURSE OUTLINE

The course outline in forestry that has been developed by the Curriculum Study Committee of the Wisconsin Association of Vocational Agricultural Instructors follows. It will assist instructors in preparing meaningful and challenging units for classroom or laboratory exercises.

Forestry

- I. Performance objectives: Upon completion of this unit the student will be able to:
  - A. Be familiar with current employment information such as job descriptions, job availability, personal training requirements, working conditions, opportunity for advancement and other factors relative to potential employment in the forest industry and will be able to relate these factors to his/her own specific needs and aspirations.
  - B. Be familiar with terminology used in the forestry industry.
  - C. Apply needed skills and knowledge to successfully manage a family-owned forest or woodlot.
  - D. Identify the major tree species in Wisconsin.
  - E. Understand the growth processes or trees.
  - F. Distinquish between the products of different tree species.
  - G. Describe and identify disease and insect damage found on common Wisconsin trees.
  - H. Explain measures which can be effectively employed to control insects and diseases common to Wisconsin's forests.
  - I. Discuss forest protection.
  - J. Operate logging equipment safely.
- **II. Concepts to Develop:**
  - A. There are career opportunities in the forest industry for young men and women at all levels of educational preparation.
  - B. A thorough knowledge of the characteristics of a species is essential for correct identification.
  - C. Many skills and techniques are needed by those seeking employment in the forest industry.
  - D. Forests and woodlands are a source of recreational activities and they also produce numerous products which contribute significantly to the nations economy.
  - E. Proper site and soil selection are essential for successful tree propagation.
  - F. Successful plantation and forest management requires that a person be knowledgeable and possess numerous skills.
  - G. The harvesting and marketing of forest products requires a special body of knowledge.
  - H. Federal and state policies and programs have had an impact on woodland and forest establishment and maintenance.
- **III. Subject Matter to Teach:**
  - A. Careers
    - 1. Current and future employment needs.
    - 2. Job description.
    - 3. Training requirements.
    - 4. Working conditions.
    - 5. Opportunity for advancement.
    - 6. Other factors relating to student needs and aspirations.
  - B. Opportunities in forest occupations
    - 1. Employee.
      - a. Genetics.
      - b. Forester.
      - c. Logger.
      - d. Processing
        - 1) Sawmill operator
        - 2) Paper industry
        - 3) Wood products manufacturing.
          - a) Furniture.
          - b) Industrial use.
      - e. Sales
        - 1) Lumber yard.
        - 2) Farm supplies.
    - 2. Owner-Manager-Grower
      - a. Pulpwood.
      - b. Saw logs.
      - c. Christmas trees.
      - d. Recreation.
  - C. Forest botany
    - 1. The study of trees (dendrology).
      - a. Classification of woody plants (taxonomy).
      - b. Use-as means of identification.
      - c. Important types of forest trees of the United States.
        - 1) Geographic distribution.
        - 2) Characteristics.
        - 3) Habitat.
    - 2. Tree physiology
      - a. Anatomy.
      - b. Growth
      - c. Reproduction
      - d. Adjustment to environment.
    - 3. Transpiration
      - a. Functions.
      - b. Amounts of water or moisture
    - 4. Geology and Forest Soils
    - 5. Production and management practices of a forest (silviculture).
      - a. Forest growth
      - b. Thinning and cutting.
    - 6. The forest environment (ecology).
      - a. Soil and nutrients.
      - b. Climate and seasons-weather factors.
  - D. Tree identification
    - 1. Genera and species.
      - a. Pine and larch.
        - 1) Characteristics.

        - 2) Habitat.
        - 3) Major commercial use.
      - b. Fir, hemlock and spruce. (1, 2, 3,-as above)
      - c. Cedar. (1, 2, 3,-as above)
      - d. Oak, maple, ash. (1, 2, 3, above)
      - e. Others (of local interest).
    - 2. Specimens and photographs
      - a. Preparation
      - b. Examination
- E. Forestry skills and techniques
  - 1. Units of measurements-forest products
  - 2. Land measurement and surveying
  - 3. Cruiser stick
  - 4. Scaling logs.
  - 5. Methods of forest inventory
  - 6. Growth rates
    - a. Methods of finding growth rates
    - b. Permanent sample plots
- F. Woodlands and forestry
  - 1. Farm woodlands
    - a. Size and extent of national total
    - b. Problems of management
      - 1) Agencies involved
      - 2) Legislation affecting
      - 3) Future potential
  - Industrial forests
    - a. Size and extent of national total
    - b. Management policies
  - 3. National, state, county and municipal forests.
    - a. Size and extent of national total
    - b. Management policies and problems unique to each
  - 4. Services from woodlands
    - a. Wood products
    - b. Soil and water conservation
    - c. Wildlife and recreation
  - 5. Forest regions of the U.S.
  - 6. Woodlands in the national economy
  - 7. History of woodland utilization
  - 8. Phases of woodland management
    - a. Forest protection
    - b. Management for continuous production
    - c. Reforestration
    - d. Harvesting
    - e. Wood utilization and national trends
- G. Nursery management
  - 1. Soil requirements
  - 2. Mechanics of planting seed
  - 3. Protection practices
    - a. Frost
    - b. Insects
    - c. Diseases
    - d. Rodents and wildlife
  - 4. Transplanting
  - 5. Harvesting
- H. Propagation and plantings of hardwood seeds, nuts and cuttings.
  - 1. Selection factors.
  - 2. Propagation by cuttings.
  - 3. Propagation by seeds and nuts.
  - 4. Nuts needing stratification.
  - 5. Germination time.
- I. Site selection
  - 1. Soil
    - a. Origin, composition, and importance of
      - 1) What is soil.
        - a) Horizons
          - 1) Color.
          - 2) Texture.
          - 3) Structure.
          - 4) Depth.
      - 2) How soil forms.
        - a) Rock weathering
          - 1) Heating and cooling.
          - 2) Water freezing.
          - 3) Plant roots.
          - 4) Wind and water
        - b) Growth and decay of plants.
      - 3) Composition of soil.
        - a) Fertilizer elements and pH
        - b) Air
        - c) Water
      - 4) Color as related to material present when soil was formed.
        - a) Air present when soil was formed.
      - 1) Effect of poor drainage.
        - b) Organic matter present when soil was formed.
        - c) Color and type of rocks which formed parent material.
        - d) Significance of soil.
    - b. Suitability of various soils for growing plants.
- J. Tree Planting
  - 1. Selection factors.
  - 2. Ordering trees.
  - 3. Plantation, windbreak and shelterbelt planning.
    - a. Selection of species.
    - b. Spacing.
    - c. Direction of rows.
    - d. Accessways and firebreaks.
  - 4. Site preparation
  - 5. Handling of nursery stock.
  - 6. Planting techniques.
    - a. Machine planting.
    - b. Hand planting.
  - 7. Protecting seedlings from white grub.
  - 8. Fertilizer usage.
  - 9. Maintenance.
- K. Plantation and forest management
  - 1. Protection from fire, insects, disease and wildlife.
    - a. Cause.
    - b. Symptoms and detection.
    - c. Prevention and control.
  - 2. Protection from competition.
  - 3. Management practices influencing growth rates.
    - a. Intermediate cuttings.
      - 1) Clear cuttings.

- 2) Improvement cuttings.
- 3) Liberation cuttings.
- 4) Thinnings
- 5) Salvage and sanitation cuttings.
- 6) Timber stand improvement.

- b. Methods that promote reproduction.
  - 1) Selection method.
  - 2) Clear cutting method.
  - 3) Shelter wood method.
  - 4) Seed tree method.
  - 5) Maturity and forest age factor.
- c. Economic aspects of intensive management.

L. Harvesting woodland products
- 1. Logging.
  - a. Felling the tree
    - 1) Proper use of saws and other tools.
    - 2) Controlling direction of fall.
    - 3) Types of backcuts and undercuts.
  - b. Limbing.
  - c. Bucking.
  - d. Skidding
  - e. Safety in logging (OSHA).
  - f. New equipment and methods.
- 2. Transportation
  - a. Loading devices and loading methods.
  - b. Truck and rail capacities.
  - c. Shipping weights and cost.
- 3. Sawmill operation
  - a. Nomenclature of the circle saw head rig.
  - b. Operation of the saw mill.
  - c. Operation of accessories and special devices.
    - 1) The edger.
    - 2) Hydraulic log turners.
    - 3) Planer.
    - 4) Others.
  - d. Power sources and supply.
  - e. Saw sharpening and mill maintenance.
  - f. Sawing quality lumber.
  - g. Custom sawing.
- 4. Seasoning lumber.
  - a. Air drying.
    - 1) Rules for piling.
    - 2) Seasoning defects and their prevention.
  - b. Kiln drying.

M. Marketing woodland products.
- 1. Considerations in marketing.
  - a. Distance from market.
  - b. Quality of product factors.
  - c. Utilization practices.
    - 1) Materials available for sale.
    - 2) Theory of highest use.
- 2. Stumpage values.
  - a. Determining factors.
    - 1) Selling price of final product.
    - 2) Logging and milling costs.
    - 3) Percentage of profit.
  - b. Use of published guides.
    - 1) Timber marketing bulletins.
    - 2) U.S. crop reporting service bulletins.
  - c. Relative merits of selling stumpage.
- 3. Sale of logs
  - a. Definition of log grades.
  - b. Detailed procedure for grading.
  - c. Variations in grading rules.
- 4. Sale of pulp and cordwood.
- 5. Sale of sawed lumber.
- 6. Sale of christmas trees.
- 7. Sale of maple syrup.
- 8. Sale of miscellaneous products.
  - a. Veneer.
  - b. Staves.
  - c. Flooring.
  - d. Lumber.
  - e. Fence posts.
  - f. Pallets.
  - g. Charcoal.
- 9. Timber sale contracts.
  - a. Merits of a written contract.
  - b. Essential points covered in a contract.
  - c. Study of a model contract.

N. Multiple use of forestry lands
- 1. Forestry research.
  - a. Role of industry.
  - b. Role of federal and state governments.
- 2. Forest products.
  - a. Lumber.
  - b. Pulpwood.
  - c. Chemical and fuel wood.
  - d. Turpentine, resin, rosin wood tar, rosin oils, pitch.
  - e. Other products.
    - 1) Maple syrup and sugar.
    - 2) Medicinal roots, barks and herbs.
    - 3) Decorations - evergreen branches, pine cones, christmas trees.
- 3. Water conservation.
  - a. Humidity.
  - b. Precipitation.
  - c. Evaporation.
  - d. Soil moisture.
  - e. Erosion and floods.
  - f. Watershed management.
- 4. Range management advantages.
  - a. To ranchers and stockmen.
  - b. To forest lands.
- 5. Wildlife management.
  - a. Practices and problems.
  - b. Considerations for:
    - 1) Fur industry.
    - 2) Gamesmen.
    - 3) Sportsmen.
- 6. Recreation areas.
  - a. Administration.
    - 1) Private lands.
    - 2) Municipal and county parks.
    - 3) State lands.
    - 4) Federal lands.
  - b. Uses.
    - 1) Picnicking.
    - 2) Hunting and fishing.
    - 3) Other recreational activities-ski courses, etc.

O. Public and private forestry policies and programs
  1. Federal responsibilities.
    a. Forest Service, Department of Agriculture.
      1) Manages nation's forest lands.
      2) Maintains experimental research stations.
      3) Cooperates with states in forest protection and forest management.
    b. Soil Conservation Service, Department of Agriculture.
      1) Develops conservation methods and techniques.
      2) Advises on conservation problems and policies.
    c. National Park Service, Department of Interior.
      1) Advises on preserving park lands in natural state.
      2) Provides staffs for national parks.
      3) Maintains national monuments.
  2. State responsibilities.
    a. State forestry departments.
      1) Direct state experimentation and conservation programs.
      2) Acquire and manage state forests.
      3) Direct reforestation of state lands.
      4) Conduct public information and education programs.
      5) Provide technical assistance to the counties for management of county forest lands.
      6) Cooperate with private owners and federal government in forest management and research.
  3. Private forestry activities.
    a. American Forestry Association.
      1) Conducts national research and information programs.
      2) Promotes and encourages improvement in use of forests.
      3) Publishes "American Forests."
    b. American Forest Institute, Inc.
      1) Originates national programs of information and education.
      2) Coordinates national "Keep America Green" fire-prevention program.
      3) Coordinates American tree farm system.
      4) Releases literature and provides information to crisis areas.
    c. School and Future Farmers of America forests.
    d. Forestry camps and experimental stations.
    e. 4-H Clubs.
    f. Farm and civic organizations.
  4. Forestry legislation
    a. Need.
      1) Protect forest lands.
      2) Guarantee forest lands.
      3) Renew harvested and devastated areas.
    b. Federal
      1) The Weeks Laws of 1911.
        a. Keystone of interstate and Federal - State cooperation in the protection of watersheds and navigable streams.
        b. Authorized appropriation of funds for the purchase of forest lands at the headstreams of navigable streams.
      2) National Park Service Establishment Act of 1916 - authorized full-time supervisory and protective responsibility for national parks.
      3) McNary-McSweeney Act of 1928 - authorized Federal appropriations for nationwide forestry research.
      4) Civilian Conservation Corps Establishment Act of 1933 - authorized approprítions for forestration, fire control and research (of historic significance - no longer in effect).
      5) Cooperative Forest Management Act of 1956.
        a) Authorized appropriations for reforestation.
        b) Approved encouragement of private services to timberland owners.
      6) Multiple Use Act of 1960
        a) Directs forest service to manage lands multiple uses as range, watersheds, wildlife etc.
      7) Forestry Incentive Program - 1973.
      8) The Forest and Rangeland Renewable Resources Planning Act of 1974
        a) Directs that long range plans be developed to assure adequate supply of renewable resources.
    c. State of Wisconsin.
      1) Forest crop and woodland tax law.
        a) Taxes deferred until crop is harvested.
        b) Reduced taxes due to long term income.
      2) County Forest Tax Law.

IV. Motivation

A. Field trip to a nearby woodlot or small forest with a variety of tree species.
B. Trip to a pulpwood processing plant for a day.
C. Visit a lumber yard with different grades and types of lumber.
D. Visit a sawmill and observe the various operations and mechanization of a modern facility.
E. Bulletin board displays.
F. Films, filmstrips and slides.

G. General information film on forestry.

V. **Learning Activities**

A. Occupational experience programs.
B. Demonstrate the safe use of a chain saw.
C. Plant trees in a nearby woodlot or school forest.
D. Prune trees in a nearby woodlot or school forest.
E. Have each student sharpen an axe properly.
F. Identify trees surrounding the school neighborhood.
G. Estimate board feet of lumber in standing timber.
H. Select and mark trees for cutting.

VI. **Materials**

A. Books

1. Berger. *Introductory Soils.* Macmillan Co.
2. Clepper & Meyer. The World of Forests. D.C. Heath Co. 1965
3. Collingwood & Brush. *Knowing Your Trees.* American Forestry Association. 1964
4. Dilworth. *Log Scaling and Timber Cruising.* Oregon State University Press. 1976
5. Duerr. *Fundamentals of Forestry Economics.* McGraw-Hill Co. 1960
6. Frome. *Whose Woods These Are: The Story of the National Forests.* Doubleday 1962
7. Hanaburgh. *Your Future in Forestry.* Richard Rosen Press, New York. 1962
8. *Madison School Forest.* Madison Public Schools Curriculum Division. 545 W. Dayton St. Madison, Wisconsin. 1963
9. McCormick. *The Living Forest.* Harper & Row. 1959
10. Meyer. *Forestry as a Profession.* Society of American Foresters. Washington D.C. 1965
11. Perry. *Exploring the Forest.* McGraw-Hill. 1962
12. Perry & Greverus. *Foresters and What They Do.* Franklin Watts, Inc. New York. 1963
13. Shirley. *Forestry and Its Career Opportunities.* McGraw-Hill, 1973
14. U.S. Department of Agriculture. *Trees - Year - book of Agriculture.* Government Printing Office. 1949
15. Vardaman. *Tree Farm Business Management.* Ronald Press. 1965
16. Wackerman. *Harvesting Timber Crops.* McGraw-Hill. 1966
17. *Wisconsin Trees and Woods.* University of Wisconsin-Extension. 1965
18. Zivuska. *U.S. Timber Resources in a World Economy.* John Hopkings Press, 1967

B. Bulletins and Pamphlets

1. "Animal Tracks," Wisconsin Department of Natural Resources.
2. "Conservation Reserve," Bulletin 227, University of Wisconsin-Extension.
3. "Deciduous Shrubs," Circular 590. University of Wisconsin-Extension.
4. Farm Safety Review - Reprints of Article on "Chain Saw Safety, "National Safety Council. Chicago, Ill.
5. "The Farmer and Wildlife," Wisconsin Department of Natural Resources.
6. "Farming Our Forests, "U.S.D.A. Forest Service.
7. "Forest Trees of Wisconsin," Bulletin No. 507, Wisconsin Department of Natural Resources
8. "The Forest Tax Laws of Wisconsin," Circular 479, University of Wisconsin-Extension.
9. "Growing and Selling Christmas Trees," Circular 425, University of Wisconsin-Extension.
10. "Growing White Pine," Bulletin No. 5, Wisconsin Department of Natural Resources.
11. "Guide for Christmas Tree Shearing, " University of Wisconsin-Extension.
12. "Horicon Marsh," Wisconsin Department of Natural Resources.
13. "Instructions On Using Scale Stick for Measuring Trees and Logs." Wisconsin: Trees for Tomorrow, Eagle River, Wisconsin.
14. "It's A Tree Country," American Forest Products Industries, Inc. Washington D. C.
15. "Learning to Know Common Wisconsin Trees," Circular 435, University of Wisconsin-Extension.
16. "Managing Small Woodlands," American Forestry Association. Washington D.C.
17. "Marketing and Harvesting Farm Timber," Circular 455. University of Wisconsin-Extension.
18. "More Money for Your Logs," U.S. Forest Service, U.S.D.A. Washington, D.C.
19. "More Money for Your Logs When Properly Cut," Wisconsin Department of Natural Resources.
20. "Now You're Logging Safely," Employers Mutual of Wausau, Wisconsin.
21. "Oak Wilt," Bulletin No. 1, Wisconsin Department of Natural Resources.
22. "Oak Wilt in Wisconsin," Bulletin No. 9, Wisconsin Department of Natural Resources.
23. "People and Timber," No. 721, U.S.D.A., Misc. Pub.
24. "Pine Sawfly," Bulletin No. 4, Wisconsin Department of Natural Resources.
25. "Producing Boltwood," Circular 415, University of Wisconsin-Extension.
26. "Pruning Pine Plantations," Pub. 529-59. University of Wisconsin-Extension.
27. "Root Rots of Conifers," Bulletin No. 2, Wisconsin Department of Natural Resources.
28. "Rural Zoning in Wisconsin," National Safety Council. Chicago, Ill.
29. "Safe Use of Power Chain Saws," Employers Mutual of Wausau, Wisconsin.
30. "School Forests - A Handbook," Circular

387, University of Wisconsin-Extension.

31. "Stem Canker," Bulletin No. 3, Wisconsin Department of Natural Resources.
32. "The Story of Lumber and Allied Products," American Forest Products Industries, Inc. Washington, D.C.
33. "The Story of Pulp and Paper," American Forest Products Industries, Inc. Washington, D.C.
34. "Tree Planting in Wisconsin," Bulletin No. 507, Wisconsin Department of Natural Resources.
35. "Wildlife, People and the Land," Bulletin No. 621, Wisconsin Department of Natural Resources.
36. Wildlife Resource Chapter of the Natural Resources of Wisconsin. Wisconsin Department of Natural Resources.
37. "Winter Feeding Wildlife," Wisconsin Department of Natural Resources.
38. Wisconsin Conservation Films, Slides, Display Sets. Wisconsin Department of Natural Resources.
39. "Wisconsin Forest Resources," Wisconsin Department of Natural Resources.
40. "Wisconsin Maple Products," No. 335. Wisconsin Department of Agriculture, Madison, Wisconsin.
41. "Wisconsin Predator Control," Wisconsin Department of Natural Resources.
42. "Wisconsin Stream Improvement," Pub. 220. Wisconsin Department of Natural Resources.
43. "Wisconsin Wild Flowers," Wisconsin Department of Natural Resources.
44. "Wisconsin Wild Life," Pub. 613. Wisconsin Department of Natural Resources.
45. "Wisconsin's Forests," Wisconsin Department of Natural Resources.
46. "Your Forester and You," U.S. Forest Service U.S.D.A. Washington, D.C.

C. Films (available from Bureau Audiovisual Instruction-UW-Madison

1. "Forest" (2458)
2. "Forest and Conservation" (0755, 0756)
3. "Forest Conservation" (0758)
4. "Forest Grows" (0759)
5. "Forest Produces" (0760)
6. "Forest Ranger" (2786)
7. "Forestry" (4558)
8. "Forests" (4925)
9. "Silent Killer" (4929)
10. "Smoke Jumpers" (4345)
11. "Studying the Sawfly" (3629)
12. "Tree Bank" (3897)
13. "Tree Grows for Christmas" (2267)
14. "Tree Portraits" (3837)
15. "Trees Are A Crop" (2269)
16. "Trees for Shelter" (4431)
17. "Trees for Christmas" (4430)
18. "Trees for Tomorrow" (2270)
19. "Trees: How We Identify Them" (4376)
20. "Trees to Tribune" (2272)
21. "Your Friend the Tree - Save It or Destroy It" (3172)
22. "Wisconsin Forests" (7921) 28 minutes $4.00 Rental. 1976.

D. Slides (available from NASCO/Fort Atkinson)

1. "The Forest" (01529)
2. "Forest, Soil and Water" (0405)
3. "Full Set of Trees of Northern United States for Identification" (0995-01074)
4. "Identifying Coniferous Trees" (01227-504)
5. "Managing Forests Through Cutting Practices" (01584-20-8)
6. "Measuring and Marketing Timber" (01585-20-9)
7. "Planning the Forest Enterprise" (01643-F58)
8. "Protecting Forests From Forest Fires" (01346)
9. "Protecting Forests From Undesirable Species" (01345)
10. "Protecting Trees From Insects and Diseases" (01583-20-7)
11. "Regenerating a Stand of Forest Trees" (01344)
12. "Safety in Operating Power Chain Saws" (01387-63-1)

E. Transparencies (Available from NASCO)

1. "The Life Cycle of Plants - Angiosperms"
2. "The Life Cycle of Seen Plants - Gymnosperms"
3. "Tree Growth"

PART I

BASIC FORESTRY INFORMATION

Chapter 1 - Wisconsin Forest

Chapter 2 - Man and the Forest Community

Chapter 3 - Forestry Careers and Opportunities

13

CHAPTER ONE

WISCONSIN FOREST HISTORY

When the Sauk, Menominee and Chippewa indians ruled the land that was to become Wisconsin, 30 million acres were covered with forest.

Five million acres of grassland and sedge marsh covered the black soil of the south and the sands of central Wisconsin, but the northern two-thirds of the area had grown into the largest and finest pine forest in North America.

The white man came and after 200 years of his domination, in 1898, the Wisconsin Geological and Natural History Survey reported a vastly changed situation.

The pine has disappeared from most of the forests and today there is hardly a township in this large area (the northern forest) where logging has not been done. Fires, following the logging operations and clearing of land, by early settlers have done much to influence forest development in Wisconsin. The growing state and nation needed lumber, but the fact is that less than half of the trees felled ever reached a sawmill.

Who was to blame?

Not the lumberjacks. They put in 13-hour days in every kind of weather, risking their lives for low wages, doing jobs they were hired to do, and using methods and technology of the times. The lumber barons were not entirely to blame as they satisfied a need for building materials demanded by a rapidly expanding population. Lack of understanding, and technology coupled with the belief that the timber resource was unlimited, led to waste that has been a black mark in American history.

The tax policies which applied to the cut-over land were almost as destructive as the fires. When logging was in progress, the pine lands were valuable and provided neeeded tax revenue. But as the trees disappeared, tax officials raised the tax rates on cutover land in an attempt to keep the revenue high. This short-sighted policy made reforestation almost impossible. The valuable saw-timber tree species took too long to grow, and 30, 40 or even more years of tax payments before the harvest were more than the average landowner could bear.

Wisconsin's government was forced to deal with problems that had no precedents. The forest resource, which had been thought of as inexhaustible, was depleted. Valuable northern land had become worthless and entire counties were turning into economic disaster areas.

The state's legislature reacted slowly but wisely. The 1927 Forest Crop Law, which allowed forest landowners to defer large tax payments until the harvest, along with research and development in the pulp, paper, plywood and veneer industries, improved the picture considerably. Advances in forest fire control and the protection of forests from insect and disease outbreak, combined with intelligent reforestation and management programs, have helped to restore much of the resource.

The forest products industry has always been an economic leader in Wisconsin, and the state government has contributed greatly to its physical and economic advancement. Over the years, the two traditional obstacles to forestry on private lands, taxes and fire have largely been overcome.

By 1927, the wave of tax delinquency on lands, which had been logged and burned, threatened the economy of the northern counties. The land needed trees, but few, if any landowners, could afford to manage their holdings and the state was unable to purchase or manage all the tax delinquent land.

Even though trees could produce income only once, (When they were cut) the land and the timber on it was taxed every year. As a result, a "cut and get out" pattern of forest land ownership became inevitable. Cutting

merchantable timber, followed by tax delinquency, was standard operating procedure, and the counties found themselves the unwilling owners of large tracts of land which no one could afford to manage on a sustained-yield basis as we know today.

A constitutional amendment ratified in 1924 changed the previous "uniform rule of taxation" to allow passage of the Forest Crop Law. Under this law, forest land is taxed annually, but the timber is taxed only after it has been cut and the income realized. The success of this system and the growth of private forestry have gone hand in hand, and today more than 600,000 acres of private land are entered under the Forest Crop Law.

Until 1953, small woodlots under 40 acres were denied these tax privileges, and many potentially valuable stands of trees were damaged by grazing or neglect. The Woodland Tax Law, enacted by the 1953 legislature, now extends the benefits of the Forest Crop Law to woodlots in agricultural areas. In addition, Department of Natural Resources (DNR) foresters give landowners technical assistance and advice in making the woodlots more productive. In 1976, more than 154,000 acres of private land were entered under the Woodland Tax Law.

Effective statewide forest fire control began in 1927 when the Conservation Commission was authorized to establish forest protection districts with responsibility for fire control throughout Wisconsin. This subject is discussed in detail later under Forest Protection.

Recently, outbreaks of destructive forest insects have caused more damage than fires, particularly in tree plantations. The DNR hired its first forest entomologist in 1952, and today entomologists work in DNR offices around the state. Presently, the DNR employs forest pathologists who coordinate disease control programs.

The application of approved pesticides is one of the entomologist's tools used in controlling destructive insects; however, biological control is being used to help solve the forest insect and disease problems also. The consolidation of forest land into large holdings by the counties, the state, the federal government and the forest industries has also helped to restore the forest resource.

A trend toward the zoning of rural lands has also made the forest management process easier. In 1933, Oneida county adopted the first rural zoning ordinance in the nation, establishing districts in which land was restricted to forestry and recreation and closed to farming and legal settlement. The zoning movement spread rapidly. In 1976, 26 northern and central counties have closed 5,000,000 acres to agricultural crops. Land owned by individual owners within zoned tracts has been purchased by state or local government, reducing forest fire hazards and the high costs of public roads and schools.

Forest lands in Wisconsin are owned by several groups, both public and private, with recreational, experimental, educational and profit motives in mind.

The Small Woodland Owner

The small woodland owner is a member of America's largest group of forest enterprisers who possess the most accessible and productive forest lands in the nation. With the help of county, state, and commerical foresters, he has

been able to put on the market some of the best products in terms of quality and quantity. At the present time, he owns about 65% of Wisconsin forest land.

Industrial Forests

Industrial forests are company owned tracts in the Industrial Forest Program, which is sponsored by the Wisconsin Forest Program, which is sponsored by the Wisconsin Forest Industries Information Committee and the Wisconsin Natural Resources Board. The program was formed in 1943. In 1976, 17 companies enrolled 1,412,606 acres under this program in 36 counties.

To be eligible, a company must have at least 1,000 acres of land under a forest management plan which has been approved by the Bureau of Forest Management of the Department of Natural Resources.

The growing and harvesting of timber crops and the manufacturing of wood into thousands of useful products, constitutes a vigorous industrial complex vital to Wisconsin's economy and well-being. Owners of Wisconsin's industrial forest realize the importance of this economic stimulus to the overall welfare of our state.

County Forests

The county forests of Wisconsin are the product of a law which is old as civilization. It is land that has passed from private into public ownership when the owners ceased to pay taxes. Under Wisconsin law, lands forfeited because of failure to pay taxes reverted to the county. The counties of northern and central Wisconsin experienced a wave of tax delinquency in major proportions. The local units of government had to find ways to make this "unwelcome" land, which no longer drew tax money, productive.

In 1927, the state legislature very wisely enacted the Wisconsin Forest Crop Law. The state attorney general ruled that counties could take advantage of the law, which allowed them to receive a small annual income from this land, in place of tax income which they no longer received.

The primary uses of county forests are for timber production with scenic and recreational values, maintenance of water levels, stabilization of wood-using industries, and employment as extra benefits. Longterm plans and policies are essential in carrying out a well-rounded land-use program in county forest management.

State Forests

The history of Wisconsin's public forests goes back to the early 1900's. It was at that time, that the idea of an extensive public ownership of potentially valuable forest land, began to take shape. These lands were originally referred to as forest reserves. The first acreage (40,000 acres) was set aside in Forest, Oneida and Vilas Counties.

State forest land acquisition continued at a slow pace until early in the 1960's. The real importance and value of these forests are more apparent today in light of our resource needs, the recreation explosion and the increasing population of the state.

It took many years to overcome a feeling of indifference to the concept of the state forest; and there was indifference, if not actual opposition. The feeling in much of the northern country was that there was no room for state forests. The forest empire of yesterday, was to be the agricultural empire of tomorrow. Time has proven this belief to be wrong. Indeed, in the north, there is ample room for both farm and forest.

The objectives of the state forests are essentially the same today as they were at the time of establishment - to protect the watersheds of the area, raise timber crops and provide outdoor recreation. The principle of multiple use is to guide in the management of these areas. Over 75% of the total acreage of state forest was not on the tax rolls or was tax-distressed land at the time of acquisition. Those lands have been restored to productivity through the public investment of time and money. Through constantly improving management techniques, the forests are increasing their potential for timber production, watershed protection and recreation.

National Forests

In 1925, Wisconsin legislation authorized the U.S. Forest Service to purchase up to two million acres of land in our state for national forests. The federal government started purchasing cut-over lands in 1928. These lands are now two national forests , the Nicolet National Forest, including parts of Florence, Forest, Vilas, Oneida, Oconto, and Langlade counties and the Chequamegon National Forest, including parts of Ashland, Bayfield, Price, Sawyer and Taylor counties.

All of these areas have been selected for their future value in providing raw materials for wood-using industries, for their need for reforestation, recreation, and their protection of the headwaters of the major rivers in the state.

The policy of the U.S. Forest Service is to develop all the renewable resources of the national forests without impairing the productivitiy of the land. Scientific forest management of the wood, water, wildlife habitat and outdoor recreation resources is assuring wide use and sustained timber production from both national forests.

Each forest is under the direction of a forest supervisor who is responsible for its overall management. For efficient administration, each forest is decentralized in ranger districts.

The headquarters of the Chequamegon National Forest is located at Park Falls. Ranger stations are located at Park Falls, Glidden, Medford, Hayward and Washburn.

The headquarters of the Nicolet National Forest is located at Rhinelander. Ranger stations are located at Florence, Laona, Eagle River, and Lakewood.

Demonstration Forests

Starting in 1946, 11 demonstration forests were established in the more important agricultural sections of the State by the Department of Natural Resources and the University of Wisconsin - Extension. These original woodlands had a combined area of 538 acres and supported sawtimber stands aggregating over three million board feet, gross log scale. In 1967, an 80 acre tract of land in Iowa County was purchased as a walnut demonstration forest.

Ten of the demonstration forests are publicly owned; one is privately owned and is managed under terms of a long-period lease. All of the forests are used for demonstration and research under a cooperative agreement between the Department of Natural Resources and the Extension Forester's Office in the Department of Forestry, University of Wisconsin - Madison.

The extension forester is responsible for all educational activities related to the management of the forests. This includes public demonstrations, field trips and other related activities.

The Department of Natural Resources is responsible for maintenance of the forests, conduct of timber sales and other operations which are in keeping with the objectives of the program.

These areas are available for visits and tours. If preparations are made in advance, a forester from the Department of Natural Resources or from the University of Wisconsin Extension can be arranged.

Timber Demonstration Forests

NAME	COUNTY	ACRES	TIMBER TYPE
Apple River	Polk	46	Red white pine
Argonne	Forest	38	Northern Hardwoods
Cairns-Ellsworth	Pierce	41.5	Mixed Hardwoods
Champion Valley	Vernon	52	Northern Hardwoods
Chilsen*	Lincoln	40	Northern Hardwoods
Dundee	Fond du Lac	64	Mixed oak/hardwood
Hardies Creek	Trempealeau	53	Northern red oak
James J. Rule	Iowa	80	Oak-walnut
Uhrenholdt	Sawyer	94	Pine/hardwood
Wausaukee	Marinette	40	Red/white pine
Wild Rose	Waushara	63	Red/white/jack pine

*Leased to the University of Wisconsin

School Forests

The school forest program started in Wisconsin in 1927 when the legislature created a statute that said, "Any city, village, town or school district may acquire land, engage in forestry and appropriate funds for such purposes."

A school forest should be a tract of land which is owned by the school district, administered by the school board and devoted to the idea of giving children a real knowledge and appreciation of the elements of nature, particularly trees.

A school forest has aims or goals that are basic to the understanding a student should have of his total environment. Some of these are:

1. That the students learn to know and appreciate nature - especially trees.
2. That the students develop an understanding of tree growth and the total forest community.
3. That students learn of animals and birds and their relationship with the forest.
4. That the students develop not only the aesthetic side of conservation but the values and uses of the forests and its products in our daily lives.
5. That students can relate conservation to the other facets of education through a program of participation in the management of their school forest.

Today, there are over 400 school forests in Wisconsin ranging in size from 40 to 800 acres. Many of these have a carefully prepared plan for the development and use of land and the resources it contains.

The school forest plays an active and major role in outdoor education. Systems such as Eau Claire, Wausau, Merrill, Marshfield and Manitowoc have developed overnight dormitories as well as classroom and mess hall facilities as an integral part of the program.

The curriculum in outdoor education generally includes nature interpretation, tree and plant indentification, geology and soils, wildlife management, and outdoor safety. A number of related subjects involving teaching opportunities in the school forest, are also included in the curriculum.

University of Wisconsin campuses are offering programs at the undergraduate, and, more recently, the graduate level. These programs train future faculty members in the role of outdoor education.

Additional information on school forests can be obtained from the Department of Public Instruction, University of Wisconsin - Extension, and the Wisconsin Department of Natural Resources.

Community Forests

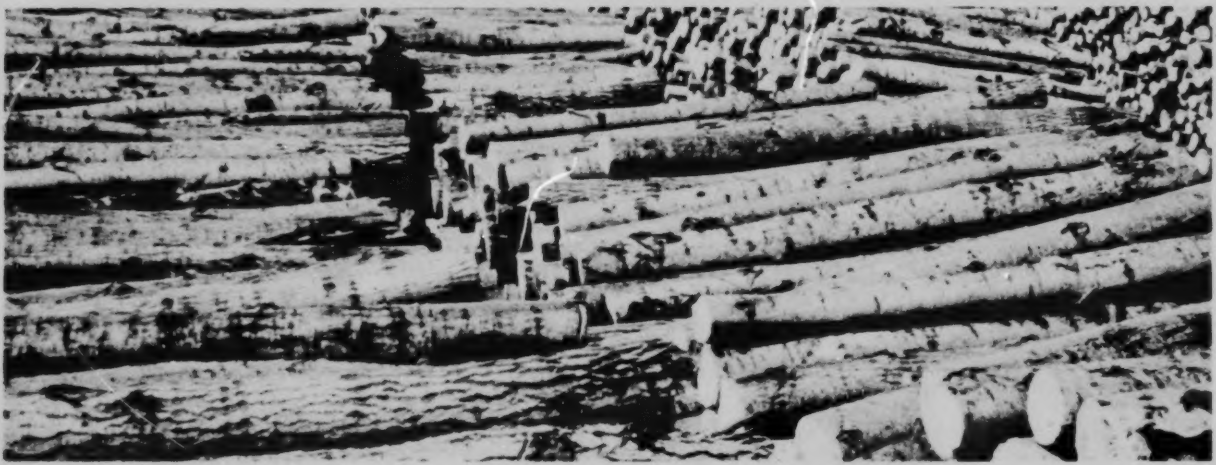
Wisconsin statutes (Sec. 28.20) state that any city, village or town may acquire land, engage in forestry and appropriate funds for such a purpose. Adults and youth groups in rural areas will find few places that give greater satisfaction in terms of recreation, multiple use, cooperative effort and pride in common ownership than does a community forest. It can serve as a community meeting ground, an outdoor laboratory for students, a home for wildlife, a place for peaceful relaxation, and a source of products for local wood - using industries.

The size of the forest can vary. If recreation is one of the planned uses, it should be large enough to include such facilities as a picnic area, playing field and other associated uses. It is also wise to have sufficient forest with actual or potential earning power to contribute to the land's upkeep.

The needs of the community should be the guiding principle in determining the kind of forest to be developed. Community forests in Wisconsin differ widely in size and use but serve the same purpose—to build a unified community spirit by cooperatively working together to develop something for the benefit of all.

Suggested Learning Activities-School and Community Forests:

1. Establish and maintain school forest signs.
2. Identify planting, pruning, and harvest operations.
3. Build an animal exclosure to study results of protection.



CHAPTER TWO

MAN AND THE FOREST COMMUNITY

The register of deeds, located at every county courthouse, has recorded the legal description of all property within the county and the names of the present owners. We must remember that ownership of land is only temporary. It is our obligation to transfer this temporary ownership to following generations without having abused or destroyed this important resource.

If our occupancy of the land is in fact a kind of tenancy, we are obligated to pay some sort of rent. The kind of moral code that takes the welfare of future generations into account, requires us to pay attention to the land's health, to respect the land and be stewards of it.

The late Aldo Leopold had a name for the active environmental conscience that can help individuals and societies tell right from wrong in their dealings with the land and its resources. He called it a "land ethic."

Americans have not always understood and practiced a meaningful land ethic. We have had laws throughout our history, but they were written to govern the relationships between men. The equally important relationships between men and the land have, until very recently, been neglected.

A land ethic, which most men believe in, can continue to guide us toward the goal of a moral relationship with the land and our own descendants.

Can we develop a land ethic?

People — and particularly children — who have become so thoroughly "civilized" by urban life that they cannot see the obvious must be taught the ethic. When children understand that men cannot always be the masters of nature, and realize that there are times when we must adapt ourselves to natural forces and patterns, the land ethic can become a reality.

A forest is not just a collection of trees. A close look at any woodland will show it to be a complex community of hundreds of different kinds of dependent, independent, competing and cooperating organisms that struggle for life. Prairies, marshes and swamps are equally complicated.

Man has been quite successful at reorganizing and simplifying communities of plants for his own purposes. His greatest successes have been in agriculture. The pioneer farmers who raised corn in southern Wisconsin are a good example. They removed the existing prairie or forest plant communities and replaced them with a single, "tame" species — corn — to which they attempted to direct the entire productivity of the soil. Modern farmers use plowing, cultivation, irrigation, pesticides and herbicides to keep their farmland "ecosystems" as simple as possible, favoring the success of their crops by eliminating competition from wild plants.

When the farming effort breaks down, nature quickly fills the botanical vacuum. During the depression years of the 1930's, many acres of marginal Wisconsin farmland were abandoned. In a matter of months, the carefully tended crop species disappeared and were replaced by grasses and broad-leaved plants. In time, fast-growing trees and shrubs moved into the abandoned fields. Today, large acreages of old farmlands support vigorous young hardwood forests.

The invasion and capture of these abandoned farms by plants, illustrates the concept of plant succession. In general, natural communities of plants are dynamic, that is, subject to great changes over time. Usually, the changes are gradual, brought about by the plants themselves.

But natural and man-made forces can also cause sudden and dramatic shifts in the kinds and number of plants living in areas affected by plowing, logging, grazing, draining, burning, flooding or droughts.

On the abandoned Wisconsin farms, the early clearing and plowing destroyed the native plant communities and prepared the soil for simple communities of crops. When the farmers left, the fields were colonized by small annual and perennial plants during the first spring and summer. In a decade or so, shrubs began to move in and take advantage of the wetter more stable soil conditions that the low plants had created. When the shrubs became well established, their shade suppressed many of the plants that had preceded them, but created favorable conditions for trees.

In a normal plant succession pattern, associations of plants become dominant in an area because soil and mositure conditions favor them. Eventually, however, the dominant community creates conditions that are more favorable for another community. Plant litter accumulates on the ground, shade increases, moisture builds up in the soil, soil acidity and soil bacteria change — and finally the community "succeeds" itself out of existence.

Forests also follow succession patterns. In Wisconsin, the "pioneer," subclimax and climax stages of forest succession are easy to observe. After land has been disturbed by fire or logging, the first tree seedlings to appear are the pioneer species — sun-loving trees that thrive in the open without competition from taller trees. Aspen (popple), jack pine, box elder, cottonwood and paper birch are common Wisconsin pioneer species.

After a fire, aspen may "take over" an area with thousands of seedlings. The large stands of aspen in our northern counties are evidence of the widespread fires that followed the first logging.

The subclimax stage follows on the heels of the pioneers. This intermediate forest stage is found throughout most of the southern two-thirds of the state. The most common trees of this stage are the oaks — burr, black, white and red — along with hickory and black cherry.

As the subclimax trees grow to maturity, their leaves cast dense shadows on the ground. Acorns sprout less frequently in the dim light and those that do grow slowly. At this point, when the oaks have reached their maximum size and dominance of the forest, community trees of the climax community begin to move in. Maple, basswood and elm seedlings can grow in the shade, and as the oaks die, fall over, or are cut, the young climax trees are "released." Because the climax species can reproduce in their own shade, they remain dominant for hundred of years.

The cornerstone of the climax forest in southern Wisconsin is the sugar maple, which is associated with basswood and elm. In the northern forest, white pine takes the place of the oaks in the subclimax or intermediate stage. The climax state is sugar maple associated with hemlock and yellow birch.

Forests support a startling variety of birds, mammals and other wildlife. The different kinds of animals that use an individual forest area are regulated by the type of ground cover and man's use of the land.

Deer thrive in the pioneer stage of the forest where shrubs, seedlings and saplings provide them with their preferred diet of twigs and other woody browse during the winter and early spring.

Insect-eating birds, such as woodpeckers, prefer climax stands of old trees. Large populations of gray squirrels live in southern Wisconsin's subclimax stands of oaks.

Changes in the forest environment have profound effects on wildlife food and cover. To manage an area for wildlife as well as timber, a forester must understand wildlife and its habitat needs, before he makes final decisions on pruning, clearing, thinning, and other kinds of cutting. It is impossible to maximize production of both wildlife and forest products from the same woodland at the same time. Modern foresters must make compromises between trees and wildlife on every tract of land they manage.

Fortunately, many methods of forest management are beneficial to wildlife. Popular game species, such as deer, ruffed grouse and rabbits, profit from large areas of young forests created by heavy cutting. But the forester must keep the welfare of non-game species in mind. The pileated woodpecker, a spectacular crow-sized resident of climax forests, has high aesthetic value. When large areas of a climax forest are cut for lumber, the pileated woodpecker loses his habitat, and the population of these birds will dwindle until another forest grows to the proper age.

What do we want? Under intensive management, most woodlands can produce fairly large amounts of forest products, recreation, or wildlife. But the same woodlands can also produce smaller amounts of all three resources under different management approaches. For some time to come, foresters will be making and guiding important decisions on management priorities. The challenge — and the responsibility — of applying a land ethic in the woods must be accepted.

CHAPTER THREE

FORESTRY CAREERS AND OPPORTUNITIES

Careers and job opportunities in the forest industry list many descriptions at all levels of educational preparation. A student must consider the future needs for training and skill as he or she prepares for a life's work in this field. The increasing demand being placed on our forest lands, based on the multiple use concept, indicates a growing need for trained personnel in this vast industry. Career and job opportunities are listed in fiber production, processing, research, sales and supplies, administration, conservation, and recreation. A student interested in one of these areas should personally investigate each possibility offered, using all sources available to make a satisfactory career selection. Also, a student must complete a personal inventory to determine the qualifications required. These will include the following:

a. a liking of the outdoors.
b. a knowledge of trees, plant and animal life.
c. self-reliance and a sense of one's surroundings.
d. a readiness for hard work.

There must also be the realization that the title or job description might mislead the student; for instance, a forester may devote a number of days to desk work for every day spent in the forest collecting data. A person who likes to fish and hunt will in all probability do best as a conservation warden. These factors must be given careful consideration before making the final decisions. The possibility of overlapping careers, skills or training in more than one field could be desirable. For example, the overlapping of soil and water conservation and forestry may be desirable since there is a close relationship between the management of these natural resources.

A study of all career and job possibilities that meet at least in part the individual's personal objectives, are an important part of a forestry unit.

* * *

PART II

MANAGING THE FOREST

Chapter 4 - Forest Botany

Chapter 5 - Forestry Skills

Chapter 6 - Growing Trees For The Planted Forest

Chapter 7 - Tending The Forest

Chapter 8 - Harvesting, Marketing And Processing Cut Forest Products

Chapter 9 - Multiple Uses Of The Forest

CHAPTER FOUR

FOREST BOTANY

Trees, like all living things, grow, mature and die. But the forest, which is a community of trees, may live indefinitely, because trees reproduce before they die.

Tree Physiology

Vegetative Reproduction: Many trees reproduce vegetatively under certain conditions. For example, most of the broadleaf trees will sprout if cut when small, while some, like basswood, will sprout regardless of age. Others, like the black locust and Lombardy poplar, will send up shoots from the roots at considerable distance from the parent tree.

The only American conifer (cone-bearing tree) which sprouts, is the redwood. But there is one conifer in Wisconsin which often reproduces vegetatively by another method. The lower limbs of black spruce often touch the ground. Where moss grows over the limb, in back of the tips, roots develop, and finally, the tip of the branch becomes a new tree.

Man uses the ability of some trees to reproduce vegetatively. Cuttings from small branches of willow or poplar, bearing several buds, can be set in the ground to grow because they will develop roots. Other methods, like budding and grafting, are used to propagate horticultural varieties. We cannot grow Baldwin apple trees from seed, rather, we must graft a twig from a Baldwin tree onto a seedling apple tree.

Reproduction by Seed: Most of our forest trees grow from seed and the way the seeds are produced, is the basis for classifying plants. For example, white pine seeds grow in pairs on the inner surface of the cone scales, while the hickory seeds are enclosed in a nut. This is the real difference between the conifers or evergreens and the broadleaf trees.

In this manual, the word "fruit" is used in the botanical sense, the seeds and seed bearing part. Therefore, the acorn and its cup, together, constitute a fruit.

The Formation of Seed: Some seed is produced from "perfect" flowers, like the cherries where both stamens and pistils are found in the same flower. In others, like the hickories, the staminate, or male flowers, and the pistillate, or female flowers, are separate, but on the same tree. This is best illustrated with the corn plant, where the tassel or staminate flower produces the pollen which must fertilize the grains in the ear. You have all seen ears of corn where some of the kernels did not develop because they were not fertilized by pollen.

With some species, like the mulberry and the poplar, some trees have only staminate flowers and others, only pistillate flowers, so that the female trees will not bear seed unless there are staminate trees in the vicinity. The Lombardy poplar, which is a horticultural variety of the European poplar, never bears seed because the variety is developed as a mutation or "freak" male tree and there are no Lombardy poplars bearing staminate flowers. Therefore, it is always reproduced vegetatively; that is, by cuttings or sprouts.

Distribution of Seed: Since some trees mature their seed in spring, while others ripen later, and seeds vary greatly in size and weight, nature has developed several methods of scattering or planting them. Seeds from the aspens are very light and so perishable, that they must come in contact with moist mineral soil within a few hours. As they are covered with cottony-down, they are carried by the wind. These two characteristics have enabled the aspen to reforest many of the burned-over areas. Pin cherry also comes in on areas after forest fire, because birds eat the cherries and may drop the seed far from the parent tree.

Seeds of pine, maple and basswood have wings so that they are carried farther by wind. The heavy nuts and acorns are often buried by squirrels and then forgotten. Seeds of trees which grow along the water are carried by streams.

Jack pine is especially interesting because it protects its seeds from fire. While most of the cones will open the first autumn, a few will remain closed, sometimes for many years. Then, following a forest fire, these cones will open from the heat and drop seeds on the denuded land. In this way, jack pine predominates on lands which originally carried mostly Norway or white pine. If jack pine grows in your vicinity, look for some of these unopened cones and place one on a hot stove and watch the scales open.

The Living Forest

A forest is made up of many species of trees, shrubs, grasses, small plants, and mosses. In addition, a host of mammals, birds, frogs, toads, snakes, insects, earthworms, fungi, bacteria, and other forms of life find their home in the forest.

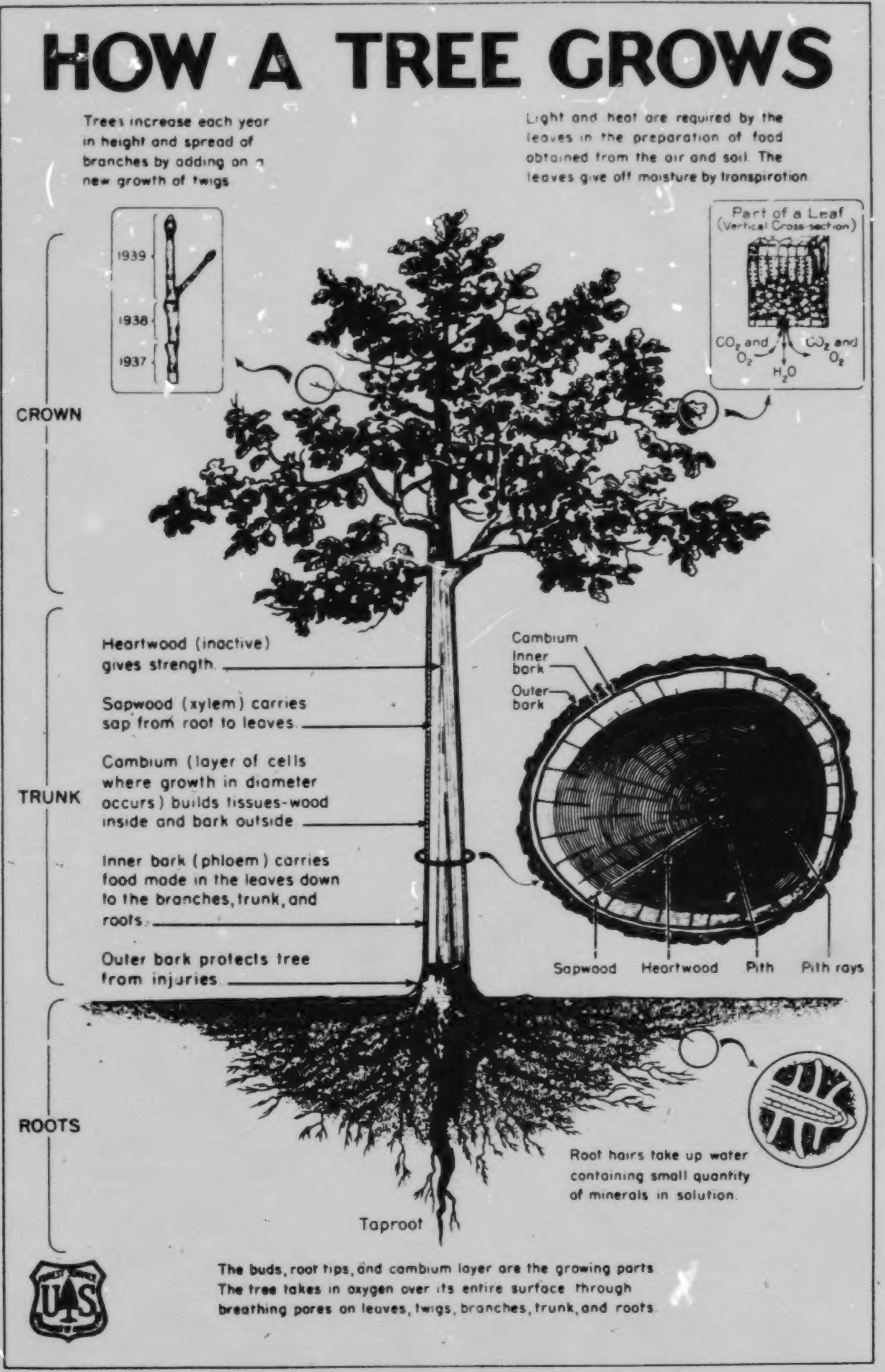
Each species of tree differs in such characteristics as length of life, growth rate, method and cycle of seeding or resprouting, and the tendency to be affected by diseases. Each also has its own special need for soil, moisture, heat, and light. These traits determine where the tree will grow and its ability to compete with other plants. The same is true with animals and smaller plants.

Thus, the plants and animals that occupy a given forest area are not just placed together by chance. Instead, they occur in definite patterns according to the climate, soils, fire history, past logging, and other factors in the area. These patterns are called forest communities.

For example, in Wisconsin, on dry sandy or rocky soils, where fires have been common, one often finds a jack pine community. Here, the forest may be a nearly pure stand of jack pine, perhaps mixed with a few red pines, also called Norway pines, and stunted aspen or birch. In this community, you will also find blueberries, hazel, sweet fern, lichens, and probably the red squirrel, snowshoe hare, and porcupine. Jack pine dominates these areas because it is especially well suited to dry, infertile soils, and to reproducing itself after fires.

Sometimes the jack pine type may be a pioneer type

Figure 1



HOW A TREE GROWS

Trees increase each year in height and spread of branches by adding on a new growth of twigs.

Light and heat are required by the leaves in the preparation of food obtained from the air and soil. The leaves give off moisture by transpiration.

Heartwood (inactive) gives strength.

Sapwood (xylem) carries sap from root to leaves.

Cambium (layer of cells where growth in diameter occurs) builds tissues-wood inside and bark outside.

Inner bark (phloem) carries food made in the leaves down to the branches, trunk, and roots.

Outer bark protects tree from injuries.

Root hairs take up water containing small quantity of minerals in solution.

The buds, root tips, and cambium layer are the growing parts. The tree takes in oxygen over its entire surface through breathing pores on leaves, twigs, branches, trunk, and roots.

1939
1938
1937
Part of a Leaf (Vertical Cross-section)
CO_2 and O_2
CO_2 and O_2
H_2O
CROWN
TRUNK
ROOTS
Cambium
Inner bark
Outer bark
Sapwood
Heartwood
Pith
Pith rays
Taproot

covering the ground after a severe burn and may be replaced by Norway pine and that by white pine. White pine may later be replaced by a northern hardwood type. In each of these successive types, the shrubs and ground flora, typical of these separate types, appears as a companion in the community with the trees. The poorer and drier the soil, the longer the time lag in this succession of transtitions. These transitions are gradual. A new species does not invade the current type vigorously until it is nearly mature or until it opens because of insect, disease or storm damage.

How Trees Grow: The growth of new wood in any year, forms a complete layer over the entire tree. That is why we can determine the age of a tree from the number of rings on the stump. Height growth occurs only in the new wood of any one year. If a nail is driven into the trunk of a ten-foot tree at five feet from the ground, it will still be five feet from the ground when the tree is 100-feet tall.

The form of trees depends on the growing space. We generally recommend a spacing of six by six feet when planting pine seedlings. We want the lower limbs to be shaded as soon as possible so that they will die and fall off, leaving tall straight clean stems, which are valuable for timber. Shade trees, which have room to spread out, have a large crown with spreading limbs and a short stem. Notice the trees at the edge of a forest; they have branches on the side toward the open, while the other side is free of branches.

All trees are composed of three parts: (1) the roots which anchor the plant and contain the rootlets necessary to absorb moisture and nutrients form the soil; (2) a stem or trunk which give rigidity to the structure; and (3) a crown bearing the leaves or needles which manufacture food used by the tree.

The growth process is complex. Moisture, containing mineral nutrients, is absorbed by osmosis from the soil through the very small roothairs. the nutrient-bearing moisture, travels up the fiberous roots and the trunk of the tree to the leaves essentially through the last annual growth ring. The leaves manufacture a simple sugar by the process of photosynthesis. The sugar solution travels down through the inner portion of the bark on the trunk and roots to supply the very thin growing cambium tissue located between the bark and the wood.

The tree grows in diameter by cell division (miotosis) of the cambium layer adding one growth ring annually. The larger portion of the annual ring is constructed during the spring; the smaller, denser and darker portion results from summer growth.

The tree grows in height and crown spread by the elongation of the buds on the branches.

Requirements for growth and survival: Each species of tree has specific requirements including: type of soil, mineral nutrients, amount of ground moisture, humidity, tolerance to shade, sunlight, temperature, frost free growing season, and insect and disease resistance. These factors, individually and collectively, will determine growth rate, maturity age, cutting practice, and what species will survive.

Effect of sunlight: Shade tolerance, the ability of a tree to survive and grow in the shade of other trees, may be considered one of the most important factors which determines the basic forest management practices.

A tree may be defined as a woody plant having a well-defined stem, a more or less definite crown, a height at maturity of at least eight to ten feet and a diameter at breast height of not less than two inches. In the United State, there are over 1,000 kinds of native trees. The Yearbook of Agriculture for 1949 entitled "*Trees*" lists 165 important forest tree species. Fifty of these are native to Wisconsin. Probably not more than 15 of these species occur naturally on any of our school forests.

Trees may be identified by their fruit, flowers, buds, bark, twigs and sometimes special characteristics such as thorns, method of branching and general shape and outline. When most of these means of identification are available, especially leaf identification, it is not too difficult to determine the species of a tree.

Since form and size, or color and character, of bark vary with size and growing conditions, too much importance should not be placed on them in identifying trees. The leaves from the lower branches of a tree may have a different outline than those from the tip of the tree. While leaves on the sprouts from a tree which was cut, may be excessively large and of unusual shape. Notice the difference between the twigs and needles of balsam trees when one has had full sunlight and the others have grown in the shade. A guide to identification of trees may be made by listing the various differences between trees. Such a guide is called an "identification key." Each item in a key gives at least two choices. The choice, which most nearly checks with the characteristic of the tree you are trying to identify, gives the next number to refer to or the species in the right hand column. An identification key for the most common trees of Wisconsin follows:

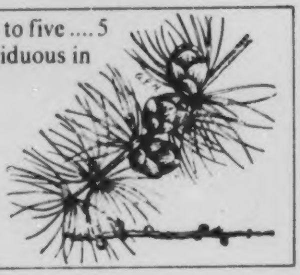
Figure 2
Tree Identification Key

1. Trees with needle-like or scale-like leaves 2
   Trees with broad leaves 10

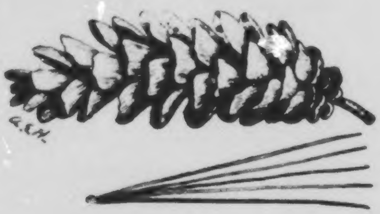
2. Leaves in the form of needles 3
   Leaves in the form of scales 9

3. Needles in bundles or bunches 4
   Needles occurring singly 7

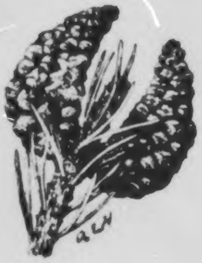
4. Needles in groups of two to five 5
   Needles in a cluster, deciduous in winter:
   Tamarack



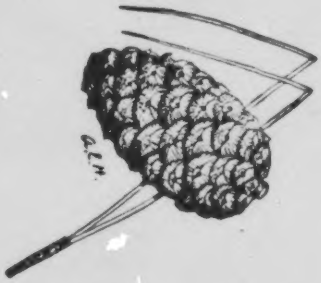
5. Needles in groups of two 6
Needles in groups of five:
Eastern White Pine



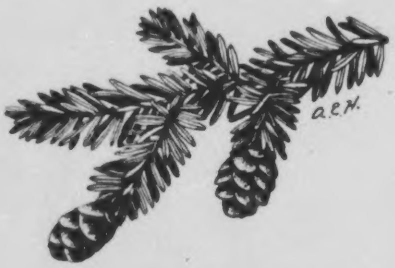
6. Needles 3/4 inch to 1-1/4 inches long:
Jack Pine



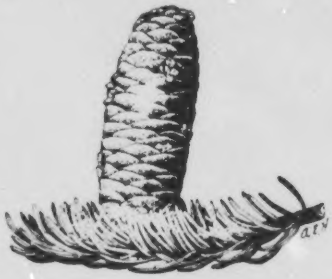
Needles 3 inches to 5 inches long:
Red Pine



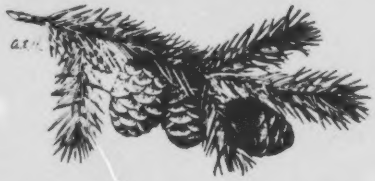
7. Needles 4 angled stiff, sharp pointed 8
Needles flat, rounded at tip
Twigs rough, cones hang down:
Hemlock



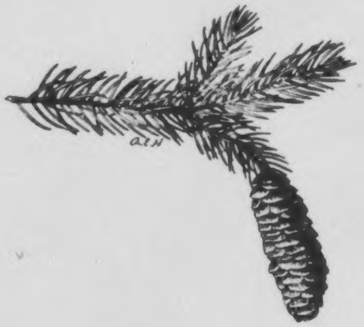
Twigs smooth, cones upright in top of tree:
Balsam Fir



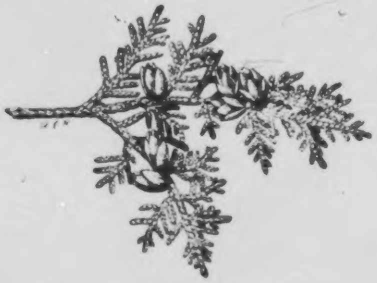
8. Cones 1/2 - 1 inch, occasionally 1-1/2 inches long, cone scales with toothed margin, twigs hairy:
Black Spruce



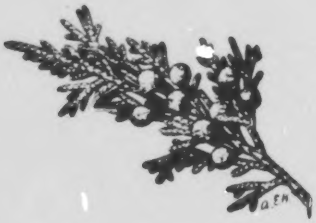
Cones 1-1/2 to 2 inches long, cone scales with smooth margin, twigs not hairy, needles having a disagreeable odor when crushed:
White Spruce



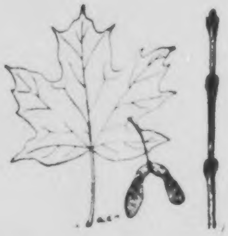
9. Leafy twigs more or less flattened, cones woody:
Northern White Cedar



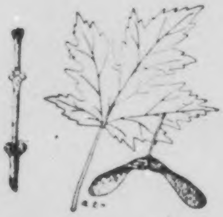
Leafy twigs not flattened, prickly, fruit is berry-like:
Eastern Red Cedar



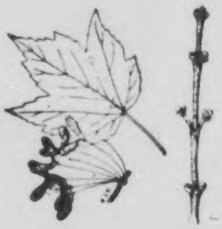
10. Leaves and usually branches in pairs, opposite 11
Leaves and usually branches borne singly and alternate 17
11. Leaves not divided into leaflets, (single) 12
Leaves divided into 3 to 11 leaflets (compound) 14
12. Teeth of leaves many and sharp 13
Teeth of leaves few and blunt:
Sugar Maple



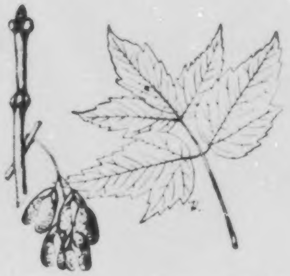
13. Leaves deeply 5-lobed, about 6 inches in diameter, margins of the middle lobe usually divergent:
Silver Maple



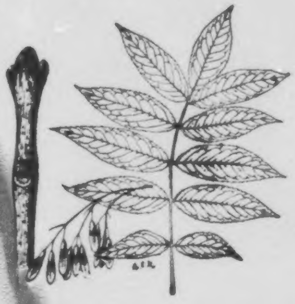
Leaves 3 to 5 lobed, about 4 inches in diameter, the sides of the middle lobe mostly converging to the apex:
Red Maple



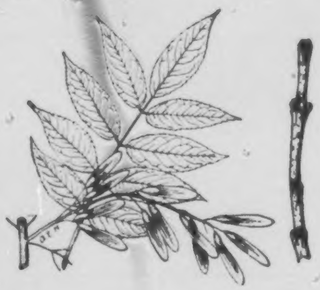
14. Leaflets 5 to 11 leaf margins entire or finely toothed 15
Leaflets 3 to 7 sharply toothed on margins:
Box Elder



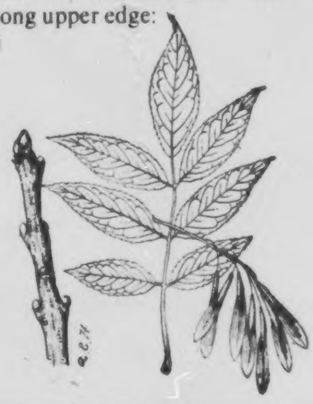
15. Leaflets with stalks 16
Leaflets without stalks:
Black Ash



16. Leaves with 5-9 (mostly 7) leaflets, leaf scars notched at the top:
White Ash



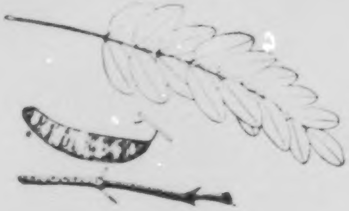
Leaves with 7-9 leaflets, leaf scars nearly straight along upper edge:
Green Ash



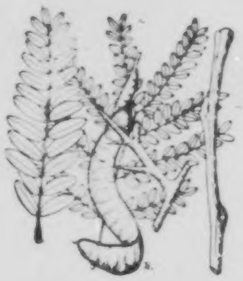
17. Leaves divided into leaflets, compound 18
Leaves not divided into leaflets, simple 23

18. Leaflets rounded or bluntpointed, twigs spiny, fruit a flat bean-like pod 19
Leaflets long-pointed, twigs not spiny, fruit rounded or egg-shaped 20

19. Leaflets 7-19, round on top, short spines on each side of main leaf stalk, fruit a pea-shaped pod 2 to 4 inches long:
Black Locust

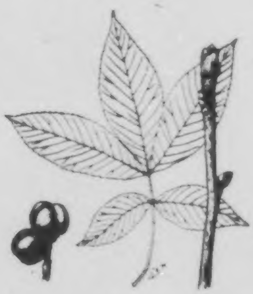


Leaves divided twice, 20-30 leaflets, fruit a pea-like pod 10 to 18 inches long:
Honey Locust

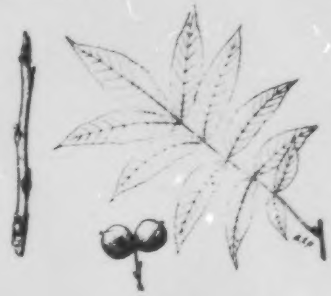


20. Leaflets 5 to 11, husk of nut splitting off 21
Leaflets 11 to 23, husk of nut not splitting off 22

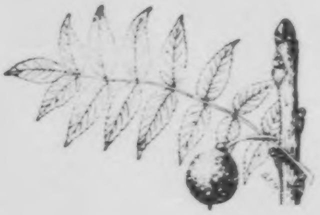
21. Leaves 8 to 14 inches long, with 5 leaves, rarely 7 leaflets, bark in thin curly plates on large trees:
Shagbark Hickory



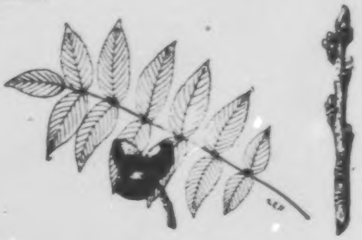
Leaves 6 to 10 inches long, with 7 to 11 leaflets, bark in old trees in shallow furrows:
Bitternut Hickory



22. Leaflets 15 to 23, nuts or single or in pairs, with husk nearly round:
Black Walnut



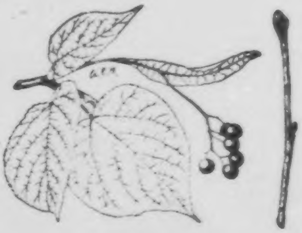
Leaflets 11 to 29, nuts generally in clusters of 2 to 5, sticky to the touch, eggshaped:
Butternut



23. Fruit, not an acorn 24
Fruit, an acorn 36

24. Leaves with 2 sides unequal and 1 side larger at the base in 2 rows on twig 25
Leaves with both sides equal, spreading around twig 29

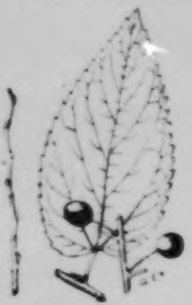
25. Leaves broad, heart-shaped, with leaf stalks more than 1-1/2 inches long:
Basswood



Leaves narrower, with leaf stalks less than 1/2 inch long 26

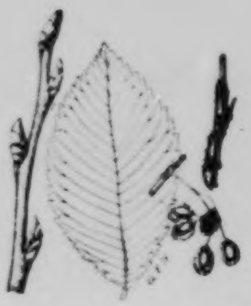
26. Leaves with 1 main vein and many parallel lateral veins 27

Leaves with 3 main veins from base:
Hackberry

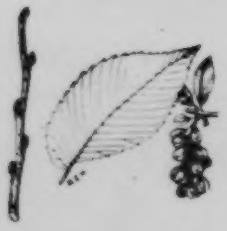


27. Twigs round, not corky winged 28

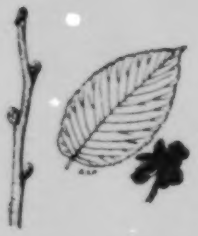
Twigs usually becoming corky winged, leaf margins doubly-toothed:
Rock Elm



28. Outer bark layers of alternately buff and reddish brown color:
American Elm



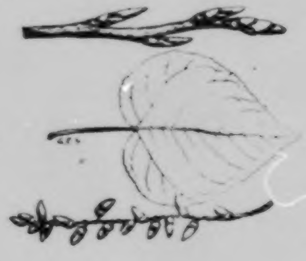
Outer bark layers dark reddish-brown, no distinct layers, inner bark gluey when chewed, leaves often creased along the midrib:
Slippery Elm



29. Leaf stalks more than 1-1/2 inches long, seeds cottony 33

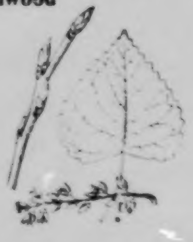
30. Leafstalks flat 31

Leafstalks round:
Balsam Poplar

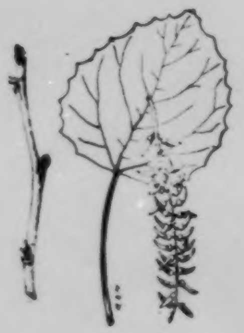


31. Leaves nearly round 32

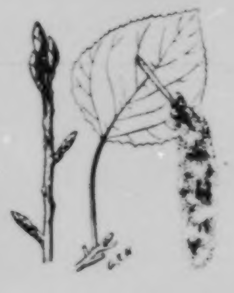
Leaves triangular in shape:
Eastern Cottonwood



32. Leaves with coarse-toothed margins:
Largetooth Aspen

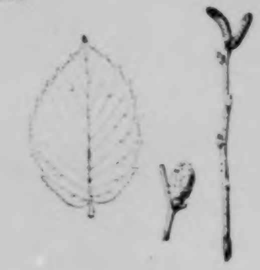


Leaves with fine-toothed margin:
Quaking Aspen

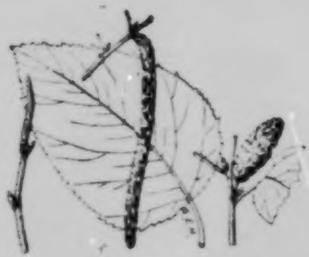


33. Leaf edges with teeth of 2 sizes and slightly irregular, fruit a cone 34
Leaf edges with uniform teeth, fruit not a cone....... 35

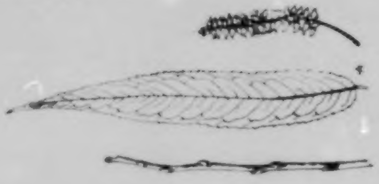
34. Bark yellowish or silver-gray, leaves with 9 to 11 main veins on each side, twigs when chewed give wintergreen smell:
Yellow Birch



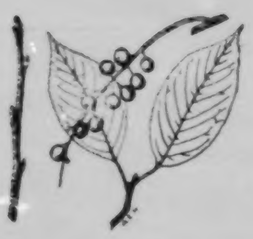
Bark white, leaves with 4 to 9 main veins on each side:
Paper Birch



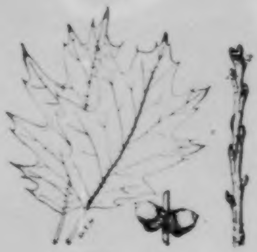
35. Leaves narrow, more than 3 times as long as wide:
Willow Species



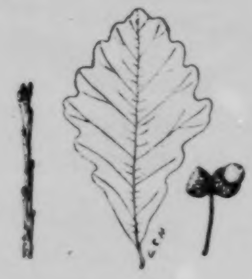
Leaves less than 3 times as long as wide, shiny on top, fruits edible cherries
Black Cherry



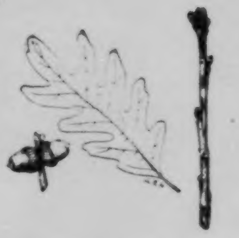
36. Leaf margin with rounded lobes.............................. 37
Leaf margin without rounded lobes:
Northern Red Oak



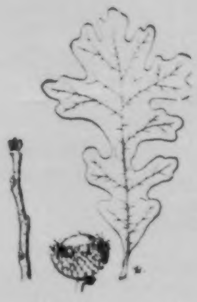
37. Leaf edges deeply lobed.. 38
Leaf edges many with uniform rounded teeth:
Swamp White Oak



38. Leaves deeply and evenly lobed, acorns with shallow cup:
White Oak



Leaves deep-lobed only near the middle, shallow lobed above, acorn half-enclosed by the large cup with fringe-like border:
Bur Oak



Wisconsin Forests

A. Yesterday

1. *Boreal forest* - limited to northern Wisconsin along lake Superior and on the Door County Peninsula. Major species were spruce and balsam fir
2. *Conifer-hardwood forest* - occupied most of northern Wisconsin. Most important area for timber production, with white pine, yellow birch, sugar maple, basswood, red oak and hemlock
3. *Pine savannnas* - scattered throughout northern and central Wisconsin. Widely-spaced jack, red and white pines
4. *Southern hardwood forest* - along Lake Michigan's shore; oak, maple, and basswood
5. *Oak savanna, or oak openings* - characteristic of southern Wisconsin: widely-spaced bur, white and black oaks with wide spreading crowns and short trunks; ground between trees was covered with prairie vegetation
6. *Prairie areas* - scattered throughout southern and western Wisconsin, covered by dense growth of grasses and herbaceous plants

Forests and prairies have drastically changed since settlement in the mid 1800's due to logging, fires, and agriculture. Still, almost 45 of every 100 acres are forested today.

B. Today

1. *Aspen-birch* - rapidly established itself on logged-over land in the early 1900's, especially where fires followed logging. Now 1/8 of the total land area in the state supports these stands. Rapidly giving way to more competitive tree species and harvesting, since the mid-1930's.
2. *Northern hardwoods* (hard maple, yellow birch, basswood, beech) - 1/6 of our commercial forest land. Supports much of the lumber and veneer industry
3. *Oak* - rapidly expanding in area, now covering nearly 20 per cent of our forests. Both white and red oaks. Mostly in southern and central Wisconsin.
4. Lowland hardwoods - common along stream banks and in swampy areas. In the north, black ash, red maple, elm, and balsam poplar; in the south, silver maple, elm, river birch, and cottonwood.
5. *Jack pine* - less than 4 per cent of commerical forest land. Central and Northwestern Wisconsin
6. *White pine* - less than 1 per cent of our forested land.

Forest Regions of the U.S.

A. Northern Region

1. Covering most of New England and New York, extending southward over the Appalachian Mountain Highlands to northern Georgia, and westward into the Lake States, including most of Michigan, Wisconsin, and Minnesota
2. Northern white pine, red or Norway pine, eastern hemlock, red and white spruces, gray, paper (white), sweet, and yellow birches, beech, sugar maple, basswood and northern red and scarlet oaks

B. Central Region

1. Covers a large amount of the central portion of the eastern half of the United States, almost to the Atlantic Coast. Extends from southern Minnesota eastward to Connecticut excluding the southern Appalachian Mountain country, south through the Piedmont area and the Cumberland Plateau to the northern parts of the southern states
2. Oaks, hickories, yellow or tulip poplar, black walnut and sugar (hard) maple.

C. Southern Region

1. Extends along the Atlantic and Gulf Coastal Plains from eastern Maryland to eastern Texas, and includes portions of Missouri, Arkansas, and Oaklahoma
2. Shortleaf, loblolly, longleaf, and slash pines; lowland hardwoods and cypress

D. Rocky Mountain Region

1. Reaches from Canada to Mexico, a length of about 1,300 miles, and from the Great Plains west to great Basin of Nevada and eastern parts of Oregon and Washington, a breadth of 800 miles
2. Ponderosa pine, lodgepole pine, western white pine, western larch, Douglas fir, and Engelmann spruce

E. Pacific Region

1. Dense coastal forests of Washington, Oregon, and the Sierra Nevada mountains of eastern California
2. Douglas fir, western hemlock, white fir, noble fir, red fir, silver fir, western red cedar, ponderosa and Jeffrey pines, sugar pines

F. Forests of Alaska

1. Along southeastern coast of Alaska, stretching for more than 1,000 miles, gradually narrowing belt of dense forest
2. Western hemlock, sitka spruce, western red cedar, Alaska cedar

Forest Botany

The forest trees of Wisconsin are one of the state's principal resources. To fully appreciate the value of the forests, small woodlands, urban areas, and roadside trees, it is first necessary to recognize them by name. Once one can identify them and realize their connections, comparative occurrence, and distribution, one will be better able to enjoy and profit from this renewable resource. The realization of that end is the purpose of this section.

Classification of Forests

A. Trees within a forest

1. *Classification by size* - based upon d.b.h. (diameter breast high) and height of the tree
    - a. Seedlings, up to 3 ft. high
    - b. Small saplings, 3 to 10 ft. high
    - c. Large saplings, 10 or more ft. high and up to 4 in. in diameter
    - d. Small poles, 4 to 8 in. in diameter
    - e. Large poles, 8 to 12 in. in diameter
    - f. Standards, 1 to 2ft. in diameter
    - g. Veterans, over 2 ft. in diameter
2. *Classification by position in the stand* - relative position in the general level of the forest canopy (the covering formed by the interlacing of the tree tops); mainly of value in even-aged forests
    - a. Dominant: trees with wide crowns above the level of the forest canopy, receiving sunlight from above and partly from the sides
    - b. Co-dominant: trees large-crowned at the general level of the forest canopy, receiving direct sunlight from above and partly from the sides. Crowns somewhat smaller than dominants, but healthy and vigorous
    - c. Intermediate: trees with much of crown below general level or pinched at general canopy level, receiving some sunlight from above with little or none from sides
    - d. Suppressed: trees overtopped by large trees and receiving no full, direct sunlight from above or the sides
3. *Classifications of tree quality*
    - a. Wolf trees: trees which hinder the growth of thrifty trees and are of little value themselves
    - b. Crooked and forked trees: the forms of which render them poor merchantable material
    - c. Fire-scarred, hollow, or rotten trees; also of little value

B. Forests

1. *By species composition*
    - a. Pure forest: one in which all or nearly all trees are of the same species
    - b. Mixed forest: one consisting of trees of two or more species
2. *By stand density*
    - a. Dense or well-stocked: over 70 per cent of crown closure
    - b. Thin or medium stocked: 40 to 70 per cent of crown closure
    - c. Poorly-stocked: under 40 per cent of crown closure
3. *By age composition*
    - a. Even-aged: practically all the trees are of the same age, even though they may vary in size because of their different growth rates
    - b. All-aged: trees range from seedlings to big merchantable timber, with all age and size classes represented
4. *By forest types*—natural groups of associations of different species of trees which commonly occur together over large areas. Defined and named after the one or more dominating species of trees
    - a. Spruce-fir and birch-beech-maple (northern hardwood)
    - b. Douglas fir-western hemlock, and sugar pine-ponderosa pine types of Pacific Coast region

Learning Activities

1. Have each student do an experiment dealing with photosynthesis.
2. Collect specimens—cones, leaves, wood and bark
3. Nature trail and guide
4. Determine age of a tree—annual rings
5. Identification contests (trees, leaves, seeds, etc.)
6. Mount leaves, twigs, wood, seeds collected on field trips
7. Make a list of trees growing on school grounds or school forests

CHAPTER FIVE

FORESTRY SKILLS

Land Measurement

Land Surveying

Land surveys may be divided into three categories: (1) an original survey, made for the purpose of writing a legal description and for finding the area of a designated tract; (2) a resurvey, made to re-establish the boundaries of a tract for which the description, as defined by a previous survey, is known; or (3) a subdivision survey, made for the purpose of subdividing a tract of land into parcels. The land surveyor makes the field surveys, calculates dimensions of areas, prepares maps, and writes legal descriptions for deeds.

Original Survey (Fig. 3)

The original survey of public lands was started in 1785 and the system used has since been modified by various acts of Congress. Nearly all the land in the United States has been surveyed at the present time. The Colonial states, including Texas, were surveyed under the old metes and bounds survey, while the balance of the United States was covered by the rectangular system of surveying. Ohio was the pilot state for the rectangular system of surveying, and modifications of this system are used at this time. The Public Land Survey requires that the public lands be divided by north and south lines running parallel to a true meridian, and by others crossing them at right angles so as to form townships six miles square. These townships in turn will be further subdivided into 36 sections (each one-mile square containing approximately 640 acres.)

In each area to be subdivided generally a state or group of states an initial point was established and located astronomically. From this point, a principal meridian was run north and south on a true parallel of longitude. In Wisconsin, the initial point is located near the village of Hazel Green (in Grant County) and the principal meridian running north and south is known as the "Fourth Principal Meridian."

First Division of Land (Fig. 4)

Standard parallels were run east and west on a true parallel of latitude every 24 miles along the principal meridian. Permanent corners were established every half mile. Guide meridians were run north and south on a true meridian every 24 miles. As guide meridians were run on a true meridian, the point of intersection with the standard parallel to the north will not be 24 miles from the prinicpal meridian or the guide meridian to the east or west, due to the curvature of the earth's surface. To continue the guide meridian on from the standard parallel, it was started at points 24, 48, etc., miles from the principal meridian.

Second Division of Land (Fig. 5)

The division of land into townships from the 24 mile quadrangles is accomplished by laying off true meridanal lines called "range lines" at intervals of six miles along each standard parallel with the range line extending 24 miles north to the next standard parallel. Latitudinal lines, called "township lines", establish township corners at intervals of six miles on the range lines, guide, and principal meridians. A vertical row of townships extending north and south is called a "range," while a horizontal row extending east and west is called a "tier", a township line. Ranges are described as east or west of the principal meridian and tiers are counted as north or south of the base lines. For purposes of description, the word "township" is substituted for "tier". A township is designated by its tier, range, and principal meridian. For example, the location of a township is defined by the description T35N, R6E (read township 35 north, range 6 east) of the fourth principal meridian.

Third Division of Land (Figure 6.)

The division of townships into sections is performed by establishing, at one mile intervals, meridional lines parallel to the east boundary of the township and by joining the section corners established at one-mile intervals with straight latitudinal lines. These lines, called "section lines", divide the township into 36 sections. The sections are numbered from one in the northeast corner of the township going east to west, west to east, etc., and end with section 36 in the southeast corner of the township. Sections are legally described by giving their number, township (tier), range, and the name of the principal meridian. The section corners that were established were usually wood posts, with trees witnessed to the section corner called "witness" or "bearing trees". In some parts of the United States, mounds of rock or pits are used as section corners.

All measurements on the original survey were done with a Gunter's chain (66 feet). This chain was divided into 100 links (each link 7.92 inches). In this system of measurements, 80 chains are equal to one mile. The instrument used to get the bearings of lines is the surveyor's compass.

Resurveys

In retracing old boundary lines, one should keep in mind that old boundary lines are considered correct whether they are or not. An obliterated corner is one where no visible evidence remains of the original survey. The corner location may, however, have been preserved beyond all doubt by landowners and those who recollect the true location of the original corner. A lost corner is one which cannot be determined beyond reasonable doubt either from original marks or reliable external evidence.

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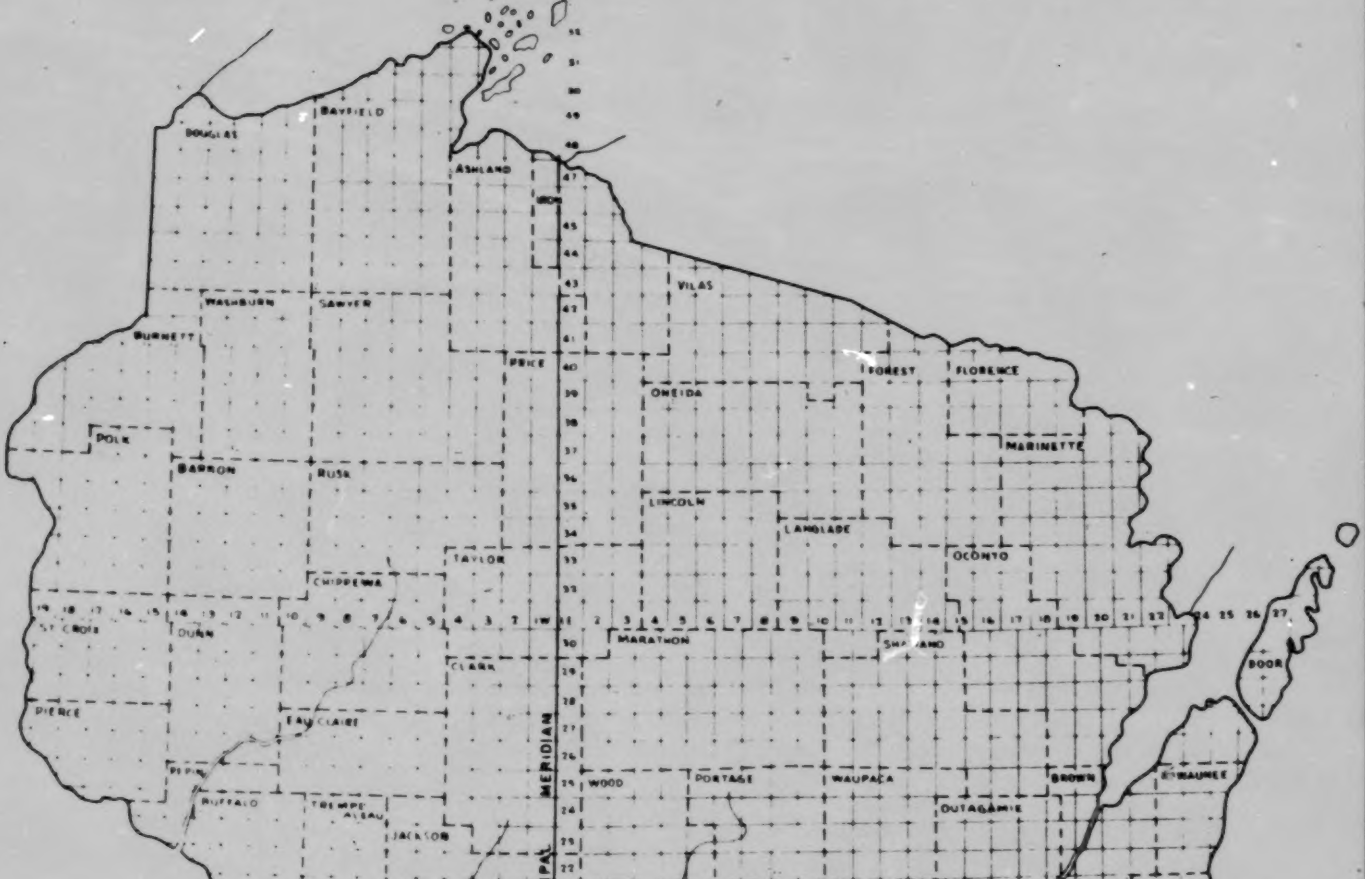
Figure 3
ORIGINAL SURVEY OF PUBLIC LANDS


DOUGLAS
BAYFIELD
ASHLAND
IRON
VILAS
WASHBURN
SAWYER
BURNETT
PRICE
FOREST
FLORENCE
ONEIDA
POLK
MARINETTE
BARRON
RUSK
LINCOLN
LANGLADE
TAYLOR
OCONTO
CHIPPEWA
ST CROIX
DUNN
MARATHON
SHAWANO
DOOR
CLARK
PIERCE
EAU CLAIRE
KEWAUNEE
WOOD
PORTAGE
WAUPACA
BROWN
PEPIN
BUFFALO
TREMPEALEAU
JACKSON
OUTAGAMIE
JUNEAU
ADAMS
WAUSHARA
WINNEBAGO
CALUMET
MANITOWOC
MONROE
LA CROSSE
MARQUETTE
GREEN LAKE
FOND DU LAC
SHEBOYGAN
VERNON
SAUK
COLUMBIA
DODGE
WASHINGTON
OZAUKEE
RICHLAND
CRAWFORD
DANE
JEFFERSON
WAUKESHA
MIL
IOWA
GRANT
LA FAYETTE
GREEN
ROCK
WALWORTH
RACINE
KENOSHA
FOURTH PRINCIPAL MERIDIAN
INITIAL POINT
BASE LINE

F P HDQTRS. TOMAHAWK, WIS 10-28-96 VEH

32

Figure 4
FIRST DIVISION OF LAND (24 MILE SQUARES)

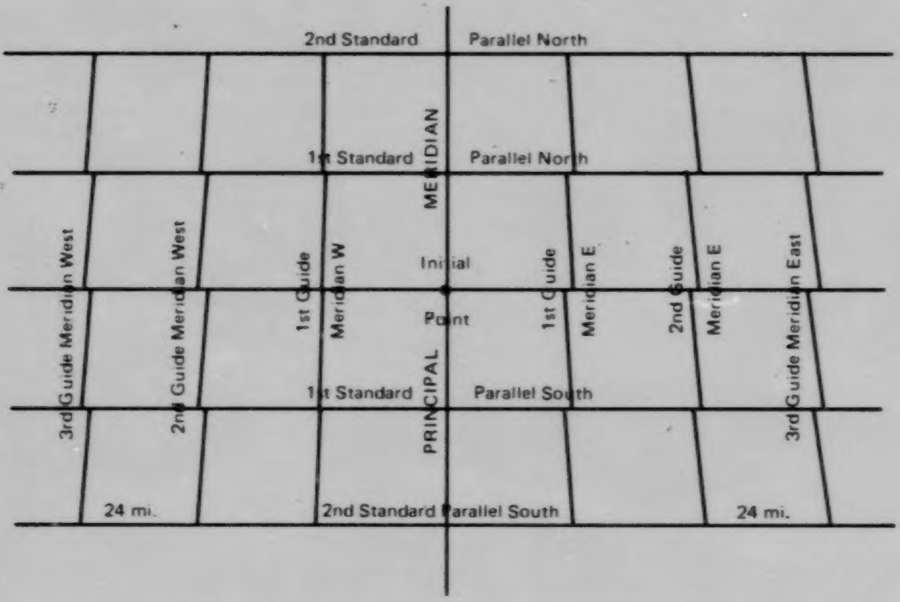
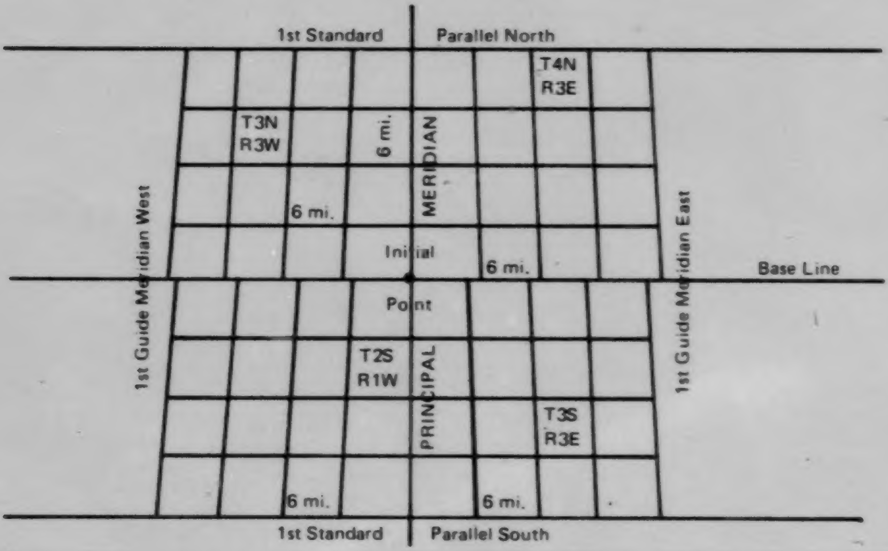
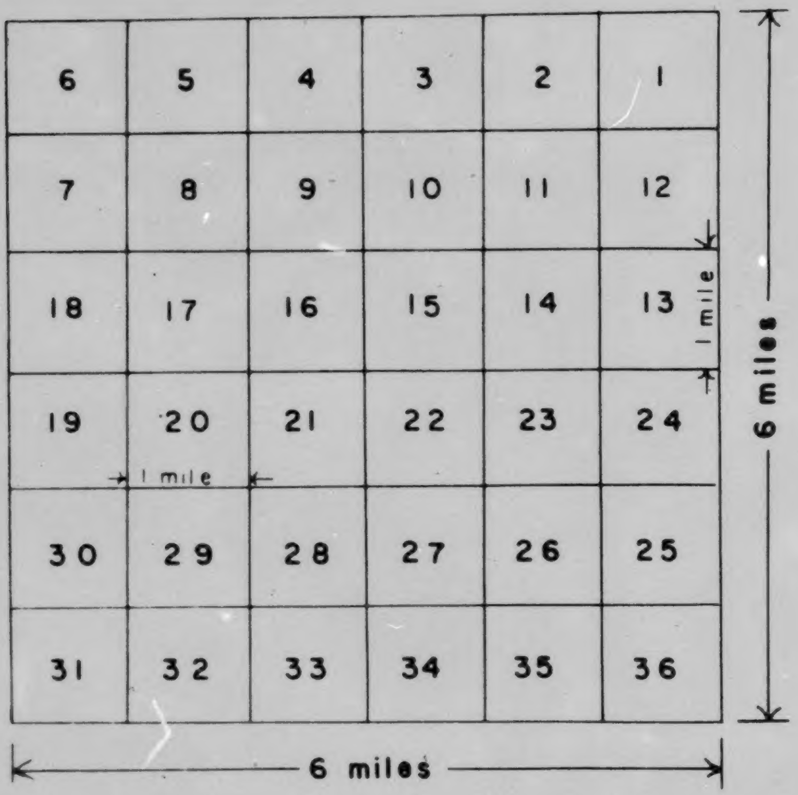

2nd Standard Parallel North
1st Standard Parallel North
PRINCIPAL MERIDIAN
Initial Point
3rd Guide Meridian West
2nd Guide Meridian West
1st Guide Meridian W
1st Guide Meridian E
2nd Guide Meridian E
3rd Guide Meridian East
1st Standard Parallel South
24 mi.
2nd Standard Parallel South
24 mi.

Figure 5
SECOND DIVISION OF LAND (Township)


1st Standard Parallel North
T4N
R3E
T3N
R3W
6 mi.
PRINCIPAL MERIDIAN
6 mi.
Initial Point
6 mi.
Base Line
1st Guide Meridian West
1st Guide Meridian East
T2S
R1W
T3S
R3E
6 mi.
6 mi.
1st Standard Parallel South

The purpose of a resurvey is to re-establish boundaries in their original positions. For a guide, the surveyor has available the copy of the original notes taken at the time of the original survey. In addition, the surveyor may ask various landowners and other persons familiar with the land, the location and evidence of the corners he is seeking. In the case of lost corners, if the corner lies along the township or range lines, that corner may be re-established by placing it proportionally between two known existing corners (either east and west or north and south). Those lost corners within the interior of a township may be relocated and established by using the double proportion method. Using this method, the corner is located proportionally by running lines both east-west and north-south.

Figure 6
SUBDIVISION OF TOWNSHIP INTO SECTIONS



A lost quarter section corner will be located midway between the section corners except in the north and west tier or sections where it will be located 40 chains north or west of the last section corner.

In relocating corners, care must be taken to rerun the original line as close as possible. When looking for original corners, careful examination of all stumps is necessary to ascertain possible old bearing trees.

Subdivision Surveys (Figure 7.)

After the section and quarter section corners have been located, the section can be further subdivided by measuring between the section and quarter section corners. Quarter-quarter section corners (1/16) are located midway between the section corner and the quarter section corner. By joining all quarter-quarter section corners, all the necessary lines have been established. Care must be taken in establishing 1/16 corners to see that they are midway between section and quarter section corners.

When subdividing land into smaller parcels, such as lake lots or city lots, care must be taken in recording the distance and direction of each line. These lines with distance and direction are plotted on a map to show the size and shape of the tract of land being subdivided. The starting point of this subdivision survey should be referenced to some known and existing survey corner.

Use of Hand Compass and Pacing

Frequently, in establishing temporary lines in resurvey, it becomes necessary to run lines that are quick and reasonably accurate. For this purpose and in timber cruising, a hand compass (forester's compass) is used. The hand compass is constructed to fit into the user's pocket. It usually has a two to three inch needle length with the compass circle graduated into 360 degrees (azimuth) or into 0-90 degree quadrants (bearings). The hand compass is a box type compass. To correct for declination (difference between true north and magnetic north) turn the compass circle to west (for west declination) the amount of the declination, or to the east (for east declination) the amount of the declination.

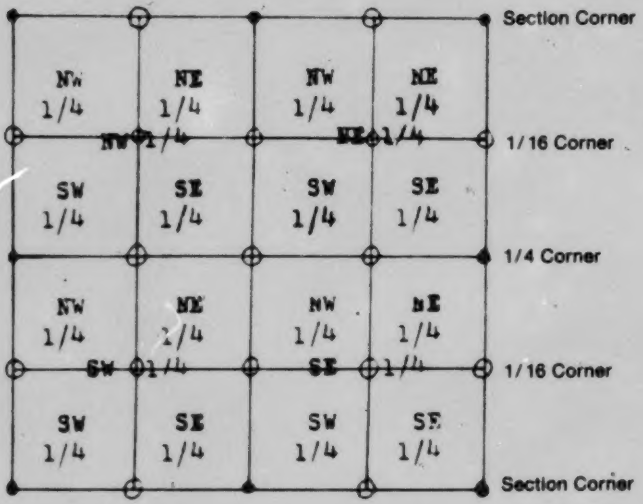
CAUTION:

Because letters are reversed on the face of the compass, for a west declination turn compass circle toward the letter E. With an east declination, reverse the process. The purpose of setting off declination on a compass is that all sights or lines will be true bearings or azimuths. This will eliminate later office calculations. When using a Silva Type compass the dial rotates and E and W are not reversed, therefore declination is turned toward W for west and E for east.

Figure 7
SUBDIVISION SURVEYS

Subdivision of a Section:

These are legal descriptions only. The interior lines of a section are not established in the original survey.



● Corners established in original survey.

○ 1/16 Corners not established in the original survey.

To Use a Hand Compass:

1. Hold firmly in both hands with elbows against body (far enough from magnetic objects such as jackknife, keys, etc.).
2. Sight toward the object or the direction wanted. (Always read the north end of needle. The south end of the needle usually has a wrapping of fine wire.)
3. Make sure that the compass is level.
4. Long 'shots' (objects farther away from the compassman) are better than short 'shots' (objects close to the compassman).
5. Be sure to sight on an object which can be seen and readily identified at all times.
6. If in doubt as to the location of your target, take another sight.
7. Rely upon the compass.

Upon occasion, in areas of iron ore deposits, "local attraction" is encountered. When using a compass in these areas, the needle will not "settle down" and will give an incorrect reading. To check against local attraction, take both foresight and backsight readings (backsight readings are exactly opposite or 180 degrees plus the foresight reading). When it is proven that there is local attraction, and it is necessary to continue your line, do it by means of projecting a straight line, or use the sun as a guide.

Pacing

Pacing is the least accurate means of measurement, although it is indispensable in timber cruising and reconnaissance surveys. A few simple rules are:

1. Be systematic. Record all paces, and check constantly against known distances. After experience, a person should have a pacing accuracy of 1/100.
2. Count *double steps only*. As used here, *a pace means two steps*.
3. Adopt a pace which can be held all day. Pace repeatedly over a measured course on such ground until a variation of less than three paces in 100 is attained.
4. Attempt to adopt a pace which will be an average of all conditions (open field, gently rolling terrain, heavy brush, etc.). Remember, when pacing up steep hills, you take short steps, therefore you need to have more paces per chain. Going down hill, the reverse is true. Consistent accuracy in pacing is obtained only by practice.

Units of Measurement in Land Surveying

1 square mile = 640 acres
1 township = 23,040 acres (more or less)
1 township = 36 square miles
1 mile = 80 chains
1 chain = 66 feet
1 chain = 100 links
1 link = 7.92 inches
1 rod = 16.5 feet
4 rods = 1 chain
1 pace = 2 steps
1 acre = 10 square chains
1 acre = 43,560 square feet

Aerial Photography

Aerial photographs have been used as an aid in forestry and allied fields for many years. Since World War II, they have been considered a basic tool. With proper photographs, instruments, and techniques, much information can be obtained in less time, at a lower cost, and with a greater degree of accuracy than was possible in the past.

The use of aerial photographs for forestry purposes falls into three main categories: forest mapping, forest inventory, and forest administration.

Forest Mapping

Many forestry operations require knowledge of the acreage or area involved. Timber estimating requires an accurate determination of the acreage in timber. In planning a timber cruise, the approximate total acreage must be known. For computing the total timber volume on any tract, the exact area must have been determined.

This means a map of the forest area you own or are involved with should be mapped before any field work commences. Maps for use in farm forestry can be made in several ways.

A preliminary map can be made by traversing the area using a compass and some form of measurement, such as pacing or a 100-foot tape. This will permit the drawing of a map showing the tract size and shape. This method is time-consuming, costs more, and the accuracy depends upon the care and experience of the fieldman.

A more accurate and faster method is to use aerial photographs. Aerial photos are not maps but they can provide distances, directions and area is a small fraction of the time required for ground mapping. By more intensive methods, very accurate maps can be prepared from them.

A map of a woodland or open field to be planted can be made quickly by tracing over the aerial photograph of the area. This method provides location of boundaries, roads, trails, water courses and open areas. Acreage determinations can be made by using a planimeter or specially designed transparent grids. One such grid is shown here.

Aerial photographs are available in all counties of Wisconsin at several places. The County Agricultural Stabilization and Conservation Service Office, the Soil Conservation Service Office or the Department of Natural Resources Forestry Offices have sets of photos and can help you prepare a map of your woodland or entire farm.

Aerial photographs can be used to produce planimetric, topographic, or specialized forest maps (such as forest type maps) at a fraction of the cost and time required by conventional ground methods. From a full set of contact prints of photographs taken according to specification, a trained person can obtain, with a stereoscope and other specialized equipment, a great deal of information.

The following basic information can be obtained with the use of the stereoscope for a forest type map:

1. Forest cover broken down further into forest type, size and density classes.
2. Road, trail and stream locations in relation to forest cover.

Forest inventory

The use of aerial photographs for purposes of making forest inventories has mushroomed since the end of World War II. Wisconsin maintains an inventory of our timber resources based upon aerial photographs. While there are many items of information to be obtained from aerial photographs, this information must be supplemented with that obtained from ground inspections.

Forest Administration

The use of aerial photographs in forest administration is perhaps the second most important use in forestry, with forest mapping ranking first. Ways in which photographs are used in forest administration are:

1. Location of roads, both permanent and temporary, and firebreaks.
2. Evaluating logging conditions.
3. Determining possible recreation areas.
4. Using the forest type maps made from aerial photographs to determine areas of merchantable timber for cutting, possible planting chances, and areas in need of timber stand improvement.
5. Locating old burns and as a tool in recording recent burns.
6. Determination of the acreage of forest types.

Obtaining and handling aerial photographs

Most of the aerial photographs taken are for use by some agency of the federal government. Order blanks for photography owned by the federal government may be obtained from the county Agricultural and Stabilization Office. Each photograph is marked with the date photography and code designation, indicating project and number. The time of photography is indicated on the first and last photograph of each strip, while the scale and project codes are on the first photography of each strip. If the flight lines run north and south, the information will appear on the north end of the photograph; if the flight lines run east and west, the information will be along the west side. When the number of the photograph has two parts, the first part is the roll number while the second part is the print number or exposure number. (See Figure 8.)

Photographs must be stored flat or tightly packed in a vertical position to prevent curling. When using the photographs in the field, a carrying device should be used to prevent them from being torn or getting wet. When marking the photographs on the emulsion surface, use a grease-type pencil for recording information of a temporary nature. The temporary markings may then be easily removed. For permanent markings, use red or black india ink or other permanent type ink.

The scale of the photograph is determined by the focal length of the camera being used and the altitude of the plane. The scale will vary for each photograph depending upon ground elevation and the tilt of the camera. Scale is

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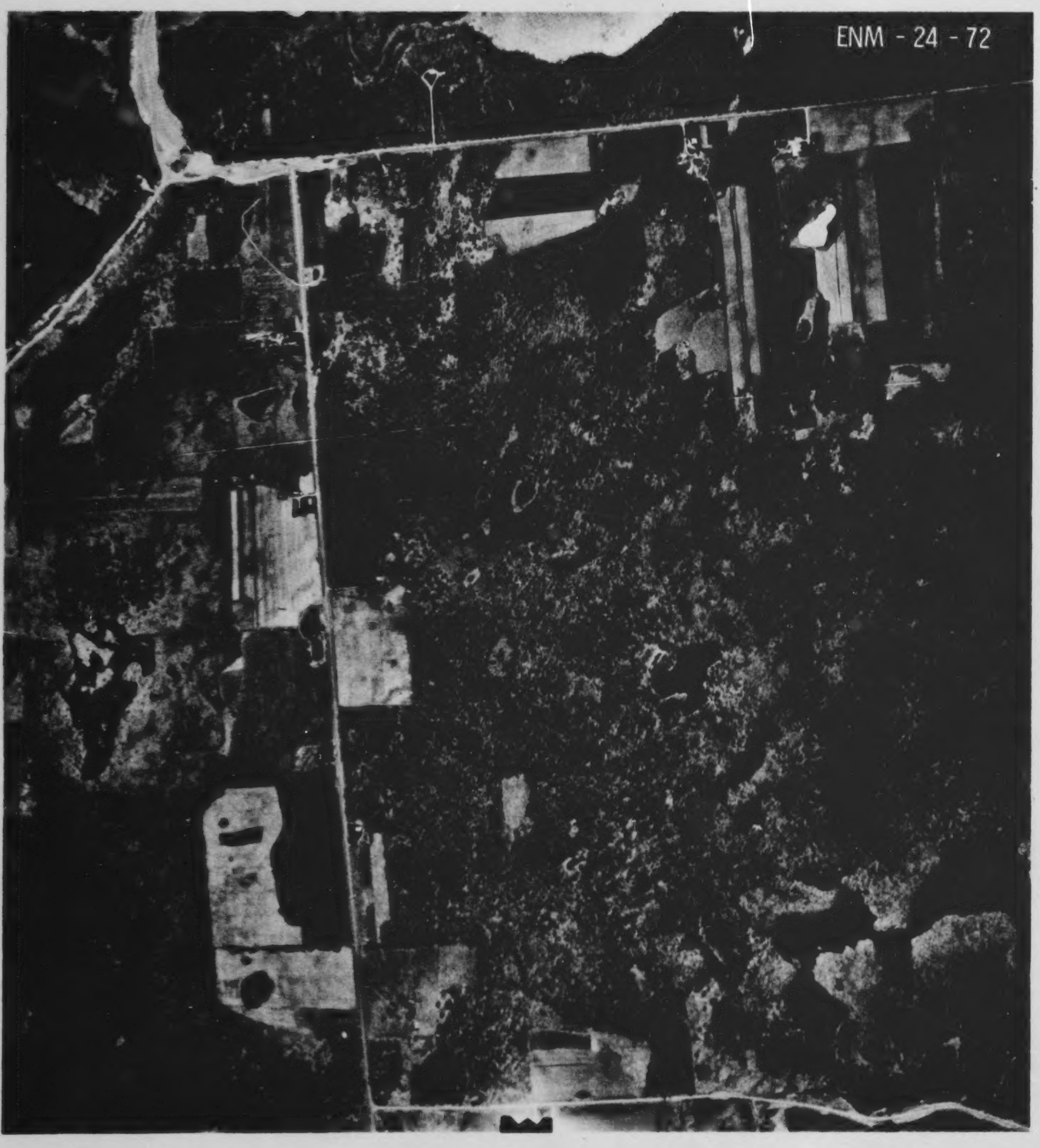
Figure 8



usually given in terms of a representative fraction, which is RF = Photo distance/ ground distance. For example, if the distance between two points on the aerial photograph is one inch, and the distance on the ground between the same points is 1,320 feet, then the representative fraction (RF) is 1:15,840 (RF = 1 inch/ 1,320 feet x 12 inches = 1/15,840 = 1:15,840).

For forestry purposes, the best season for photography is summer. Trees must be in full foliage in order to form sharp resolvable images. For engineering or cartographic purposes, fall and spring photographs are best.

Two types of film commonly used in forestry work are panchromatic and infra-red. Infra-red film is the most desirable where the photographs are to be used stereoscopically to make timber-type maps. The tonal contrast runs from black to white. Coniferous species show dark black to light grey tones, whereas deciduous trees photograph from dark grey to white. All water will show pure black. Panchromatic film is used where timber-types are either pure hardwood or pure softwood. This film is relatively insensitive to green and, therefore, shows all foliage in approximately the same shade of grey. Panchromatic film has the advantage in that physical objects are shown in clear detail, i.e., roads, streams, buildings and variations in terain.

Stereoscopy

Stereoscopy is the science of viewing objects in three dimensions. As applied to aerial photogrammetry, it pertains to the height (or depth) of perception which one achieves by simultaneously viewing with his left and right eyes the photographic images of an object as recorded from left and right camera stations. Two overlapping photographs which can be viewed stereoscopically are termed a "stereo pair." In aerial photogrammetry, the stereo pair usually consists of any two vertical aerial photographs which were taken from successive camera stations along a flight line.

For stereoscopic purposes, all aerial photographs should have a semimatte (dull) finish on the emulsion surface for making timber-type maps. In engineering and cartographic work, the glossy (shiny) emulsion surface is superior. The photograph should be printed on double weight paper to give the greatest stability. Aerial photographs come on single or double weight paper.

To prepare photographs for stereoscopy, the following procedure should be used:

1. Take a stereo pair of aerial photographs and separate them (along the flight line) approximately the same distance as the distance between the observer's eyes. (This is already done in Figures 9 and 10.)
2. Place the stereoscope over the photographs with the lenses separated the same distance as the distance between the observer's eyes (approximately 2-1/4").
3. Observe a common object (be sure both eyes are open). If two images (of the same object) are seen, then move the photographs further apart or closer together along the flight line until only one object is seen. You now have stereovision.
4. Secure the photographs to a tabletop or mounting board with drafting tape so that the photographs will not move. Overlapping objects can be seen stereoscopically by curling one edge of one print.

Figure 9
ASPEN POLE STAND

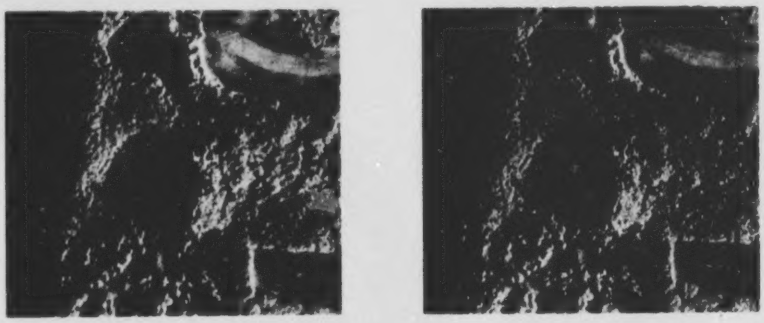


Figure 10
RED PINE PLANTATION

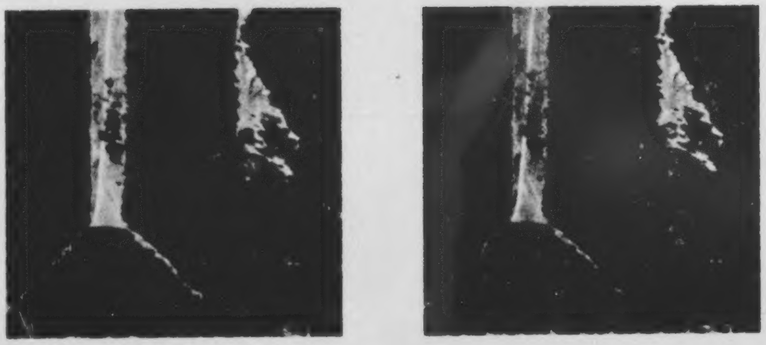


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Figure 11
FIELD SHEET

COUNTY RICHLAND TOWN SYLVAN T 11N R 2 W

MAPPED BY C. RIECK DATE SEPT. 9 19 59

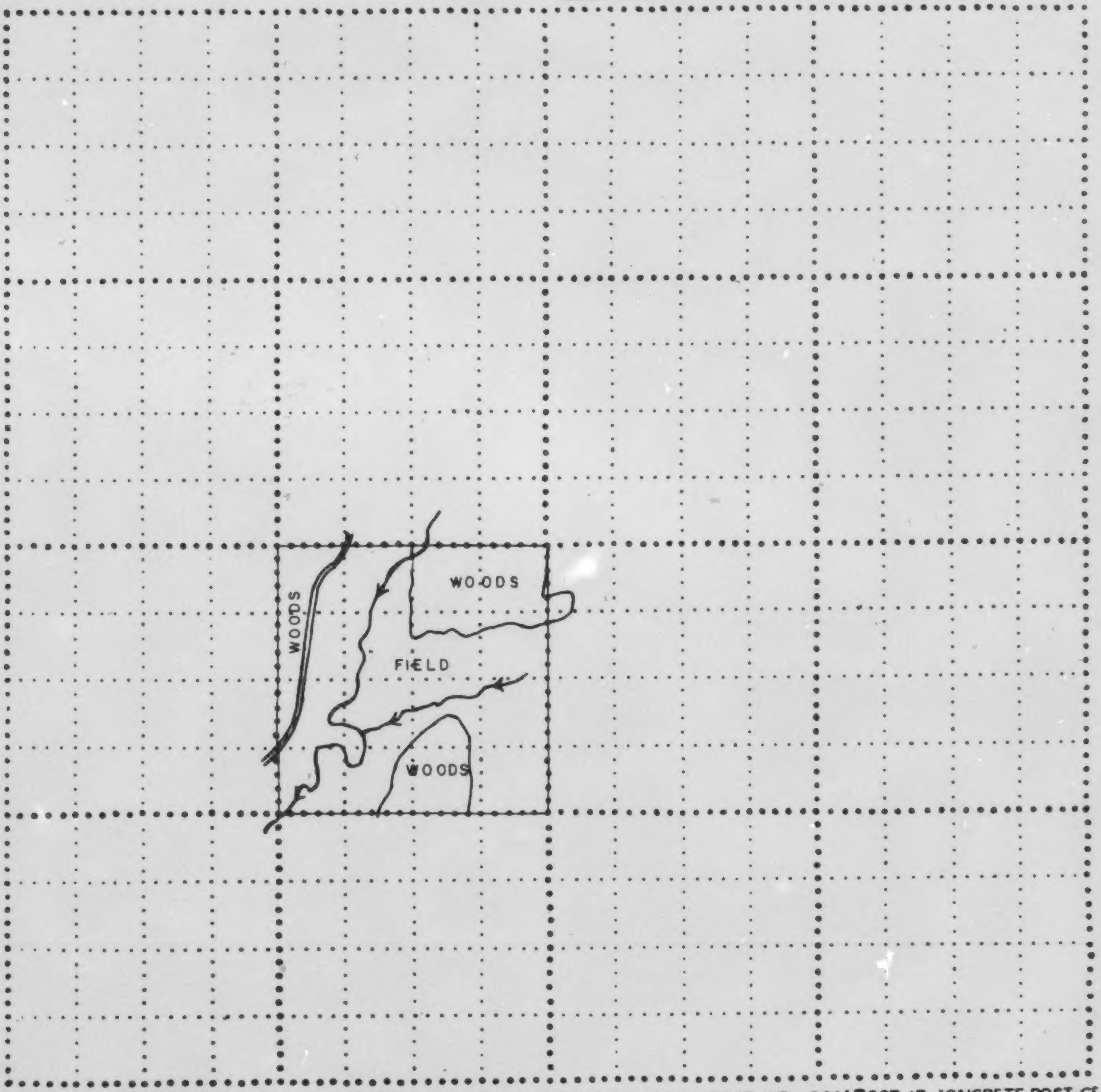
TOPOGRAPHY ROLLING SECTION 1

SOILS OWNER

X	

— OTHER DATA —

ENLARGED FROM PHOTO
WQ 4P – 49
SCALE OF PHOTO =
1: 20,000



INDICATE – BEARING TREE-BT; MARKED TREE-MT; SQUARED TREE-ST; WOOD POST-WP; IRON POST-IP; CONCRETE POST-CP

Measuring aerial photographs

Measurements that are taken from the aerial photographs are useless until the representative fractions (RF) or scale is known. Once the scale or RF is known, area, and distance measurements can be determined. Listed below are examples and solutions of problems using various equations for determining scale or representative fractions.

Area on an aerial photograph can be measured by square grids, dot grids and planimeters. (Figure 11.)

Square grids are set up so that each square represents four-tenths of an acre. Select an area of woodland, count the number of squares, multiply by .4, and your answer will be the number of acres in that woods. Square grids are made for each common scale. The local Department of Natural Resources forester will lend you the correct grid for the photograph you are using. Dot grids can also be used for determining area. Each dot represents one acre (640 dots per section.)

To enlarge the scale of the map from the photograph, lay the grid over the photo (Be sure to use the scale which correctly fits the photograph.) Transfer the detail from the photo to the larger map sheet by counting from the same common starting point i.e., if a stream crosses the area, you are enlarging six chains from the SW corner, then put the stream six chains from the SW corner on the enlargement. Remember that each line on the grid is equal to two chains, whereas each dot on Figure 11 represents one chain. Figure 11 is a drawing showing a 40-acre area taken from an aerial photograph.

Planimeters will give you area readings by conversion once the scale is known.

Distance can be determined once the scale is known by simple proportion or by using the various photo chainage scales that are available.

Photo interpretation

The art of aerial photograph interpretation is best understood when the interpreter has an intimate knowledge of land and trees. This knowledge can be obtained only by experience. One fundamental point to remember is that "man-made" objects, i.e., roads, railroads, fences, and dams, seem to be in straight lines; whereas objects in nature, i.e., streams, lakes, and timber types, take curved or serrated lines.

Identification of objects on photographs can be ascertained by:

1. shape
2. dimension (size)
3. tone
4. texture
5. shadow pattern
6. site (where growing or established)

Illustrations of the above area:

1. Shape—roads with sharp smooth curves, whereas railroads need a long smooth curve
2. Dimension—barn would appear much larger than a house or shed.
3. Tone—water is black on infra-red photographs, oak is white.
4. Texture—seedlings and saplings have a very fine, lacy appearance, whereas the crowns of saw-timber size trees are coarse and pebbly.
5. Shadow pattern—balsam tree shadows appear as cone-shape while elm tree shadows are shaped as umbrellas.
6. Site—cedars are commonly found in a swamp, jack pine on light, sandy soil, etc.

On aerial photographs we can measure. . .

1. Tree crown size
2. Tree height
3. Timber stand density
4. Number of trees

While we cannot measure. . .

5. Cull
6. Stem diameter

On black and white infra-red photographs, the tonal characteristics for the major timber types in Wisconsin are:

1. Northern hardwoods and Hemlock-white to light grey
2. Pines-
   - Jack Pine—black
   - Red Pine—dark grey
   - White Pine—medium grey
3. Balsam Fir, White Spruce—dark grey to black
4. Aspen—light grey
5. Swamp and bottomland hardwoods—white to light grey
6. Oak and Scrub Oak—white
7. Tamarack—dark grey
8. Black Spruce—black
9. Cedar—medium grey
10. Grass—light grey
11. Brush—light grey
12. Swamp—light grey

On aerial photographs of small timber, (less than pulpwood size) the crowns are indistinct and interwoven, whereas pulpwood-size timber and larger will have distinct crowns.

Forest Inventory

Taking an inventory is a necessary function in forestry as in any other business. Measuring the forest is sometimes called timber cruising. This is usually done by measuring individual trees on selected sample plots.

Measuring Individual Trees

Determining the Height of a Tree

Learning the total height of a standing tree is usually of little value when one is interested primarily in learning how much of the total length is usable. Some trees have a short stem and a tall crown, while others may have a long stem or trunk and a relatively short crown. It is possible to make close estimates of the usable, or merchantable length, or height of a standing tree by any one of three units of measure. It should be kept in mind that by merchantable or usable length, we refer to that part of the stem or trunk which has value for processing into some useful product such as lumber, railroad ties, pulpwood, box boards, etc.

Total Merchantable Length in Feet

The most important factor in arriving at the merchantable length in feet is the smallest diameter of log or bolt which will be accepted, and then estimating on the trunk of the tree where this diameter occurs. For logs, this smallest diameter is eight inches—pulpwood it is four inches. One of the simplest of all methods to determine the total length, after the point of minimum diameter is estimated, is to use a Merritt Hypsometer.

This is a wooden or metal stick, usually about 36 inches long that enables the user to measure the merchantable length of a standing tree. Graduations on the stick are based on the length-of-arm class of the user, the distance from your eye to your index finger pointed up. Learning this length, you start at the left end of the stick, considered "zero", and measure off intervals corresponding to your arm reach.

For example, a 25" arm reach will have a 6.2" interval between each 16 feet of height. Each successive interval should be marked and numbered as to total height. Remember, each interval equals 16 feet of tree height.

Merritt Hypsometer Length-of-Arm Class

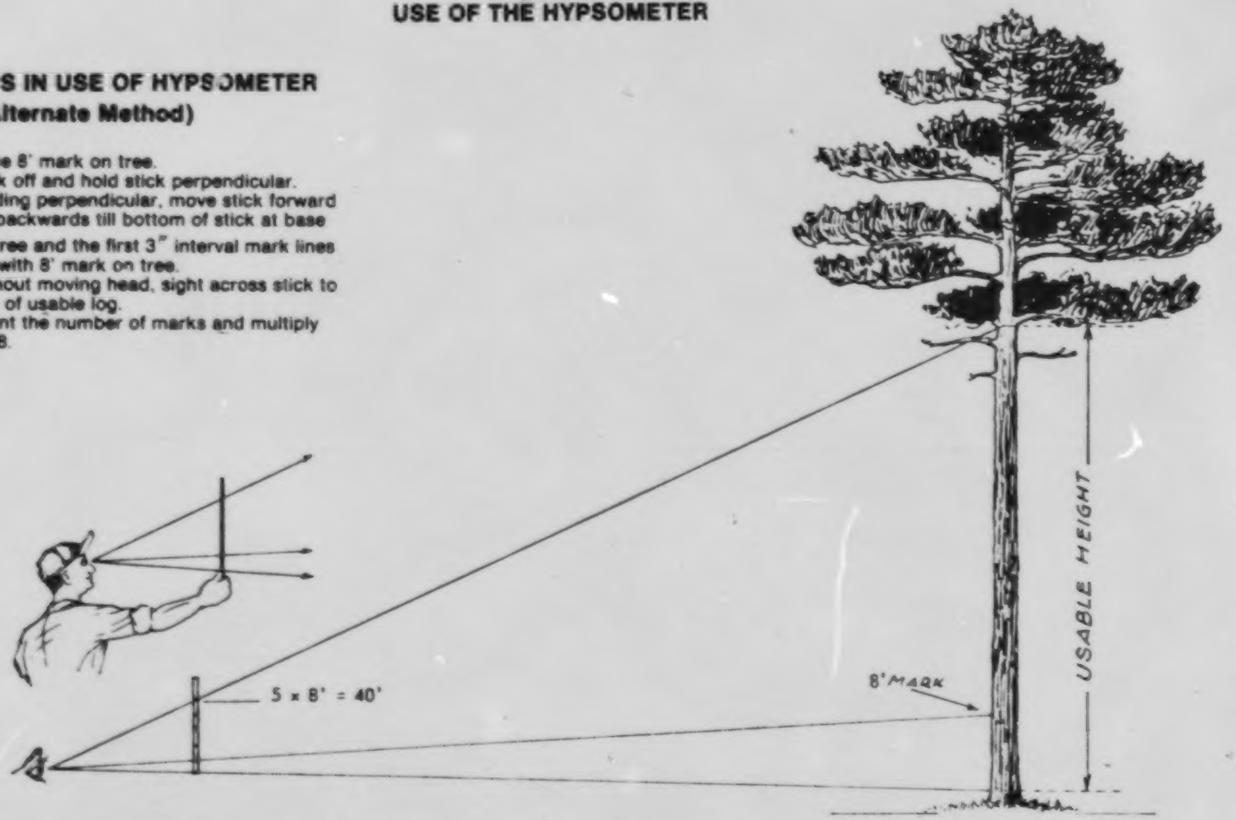
Length-of-Arm Class (Inches)	23	25
Graduating Interval (Inches)	5.4	6.2

The Hypsometer is used for height determinations by standing 66 feet from the base of the tree. By grasping the stick vertically near the zero end, you extend your arm fully and make certain the stick is perpendicular to the ground. Sight along the bottom of the stick to the base of the tree. Then, **without moving your head,** glance up toward the merchantable top of the tree (8" minimum diameter or at the base of a crotch) and note the point on the stick crossed by your line of sight. This reading gives you the height of the tree in number of 16-foot legs. You should make your estimate to the nearest one-half log or 8 feet of height. The Hypsometer is on the back side of the Biltmore Stick.

Figure 12
USE OF THE HYPSOMETER

STEPS IN USE OF HYPSOMETER
(An Alternate Method)

1. Place 8' mark on tree.
2. Back off and hold stick perpendicular.
3. Holding perpendicular, move stick forward or backwards till bottom of stick at base of tree and the first 3" interval mark lines up with 8' mark on tree.
4. Without moving head, sight across stick to top of usable log.
5. Count the number of marks and multiply by 8.



Determining the Diameter of a Tree

The diameter of a tree is measured in inches at a point 4-1/2 feet above the ground. This is known as diameter breast height, abbreviated D.B.H. It is a measurement of the outside bark diameter of a tree.

As in measuring tree height, the other side of the cruiser stick used as a Merritt Hypsometer can be used to measure diameters. You can make your own diameter or Biltmore stick by following these instructions. You must find your length-of-arm class as you did in making the Hypsometer—by measuring the distance in inches from your eye to your index finger with your arm fully extended. With this measurement determined, measure from the left end of the stick the distances given in Table 1. Label each mark with the diameter that is indicated. For example, if your arm length is 25 inches, the table indicates that you would measure 5.37 inches from the left end of the stick and mark it 6, then measure 7 inches and mark it 8 and so on. Divide the space between the successive numbers with a long line. This will give you the odd-numbered diameters.

To use your Biltmore stick for measuring tree diameter, grasp the stick firmly with your arm extended at a right angle to your body. The stick should be at a right angle to your arm and just touching the tree at D. B. H. Glance toward the left side of the tree and move the stick until the left end lines up with the outer edge of the tree. Then, *without moving your head,* glance toward the right edge of the tree and observe the point on the stick crossed by the line of sight. This reading gives the diameter of the tree. Most trees are not truly round so take two readings and average them. The second reading should be made at right angles to the first.

Table 1

Diameter of tree - inches	Interval to be marked on stick	
	23" arm reach	25" arm reach
3	2.82	2.83
5	4.53	4.56
6	5.34	5.39
7	6.13	6.19
8	6.81	6.96
9	7.63	7.72
10	8.35	8.45
11	9.05	9.17
12	9.73	9.86
13	10.39	10.54
14	11.03	11.21
15	11.67	11.86
16	12.29	12.50
17	12.89	13.12
18	13.49	13.73
19	14.06	14.32
20	14.63	14.91
21	15.18	15.48
22	15.72	16.05
23	16.26	16.60
24	16.79	17.14
25	17.31	17.68
26	17.81	18.20
27	18.31	18.72
28	18.80	19.23
29	19.29	19.73
30	19.76	20.22

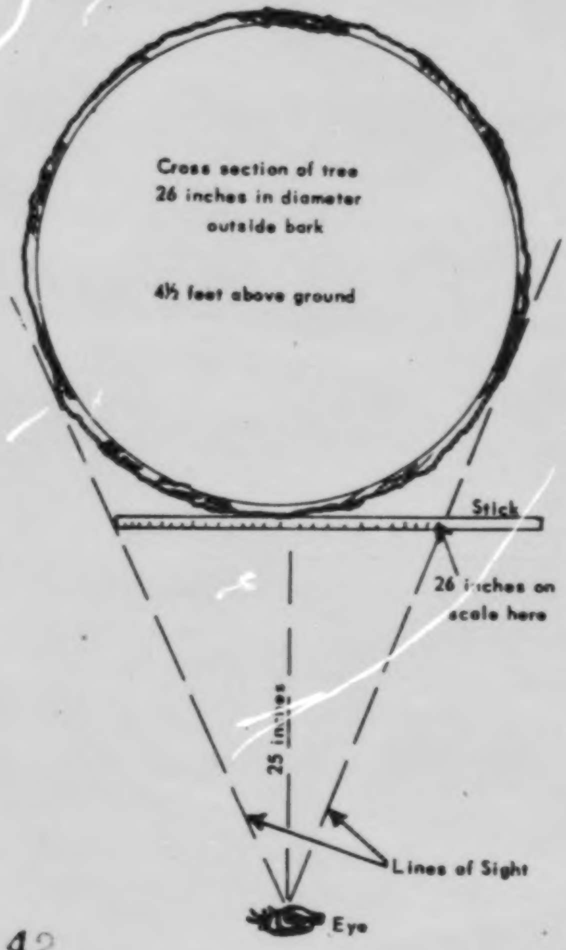
Tree diameters are usually grouped in 2-inch diameter classes. This means that the 14-inch class would include all trees measuring between 13 to 15 inches. The 16-inch class would include all trees from 15 to 17 inches in diameter, and so on.

Two measurements of a standing tree are needed in order to estimate the volume of a tree.

1. The diameter of a tree at 4 1/2 feet above ground (D.B.H.).
2. Usable height of a tree, usually in units of 16-foot logs.

Figure 13

Measuring the diameter in inches outside bark of a tree at a height of 4½ feet above ground. (Known as diameter breast high, abbreviated D.B.H.)



Estimating Volumes

Volumes are usually stated in board feet, cords or cubic feet. Cubic foot volume tables are used primarily in research, therefore they will not be discussed further.

To estimate the board foot volume in a standing tree, first measure the D.B.H. with the Biltmore stick. Next, measure off 66 feet from the tree base and estimate the merchantable height with the Merritt Hypsometer. Usable heights are estimated to an 8" minimum diameter or to a fork in the merchantable trunk. From a volume table, you can determine the tree volume. Example: a tree measuring 20" D.B.H. and 3 logs in usable height has a board foot volume of 364. (Table 4)

Cordwood size trees are measured for diameter and estimated for height similar to the way in which sawtimber trees are measured. Instead of measuring height in log lengths, it is estimated in *8-foot bolt* lengths. This is actually the 1/2 log interval marked on the stick. The same principles apply as in sawtimber trees except that bolt lengths are not divided into half lengths but are kept in even bolts, 1, 2, and so on. Thus, a tree with 24 feet of usable length is classed as a 3-bolt tree. Usable height is estimated to a 4" minimum top diameter. After diameter and height are determined, the volume can be obtained by using a cordwood volume table. Example: a tree measuring 8" D.B.H. and 4 bolts in usable height would have a volume of 0.09 cord. In other words, it would take about 11 trees of this size to make one cord of pulpwood.

Through practice, you can estimate tree volumes quite accurately with the cruiser stick.

Pulpwood

A pulpwood cord is composed of bolts, or logs, 100 inches long, placed in a pile four feet wide and four feet high. This represents a gross cubic volume of 133 cu. ft.

Board Foot

A board foot is represented as 144 cubic inches of lumber. As an example it could be a board 1" thick 12" long and 12" wide.

How to Measure 66-Foot Distance.

It is not necessary to use a tape measure to find the correct distance from the tree each time you estimate a tree height. Measurements can be made quickly and quite accurately by pacing. A pace is equal to *two ordinary steps.*

Lay off a 66-foot distance with a tape measure and mark the ends. Check the number of paces you need to take to cover this distance. If you start your stride with your *right* foot the second step will be when you *left* foot

Figure 14
A PULPWOOD CORD

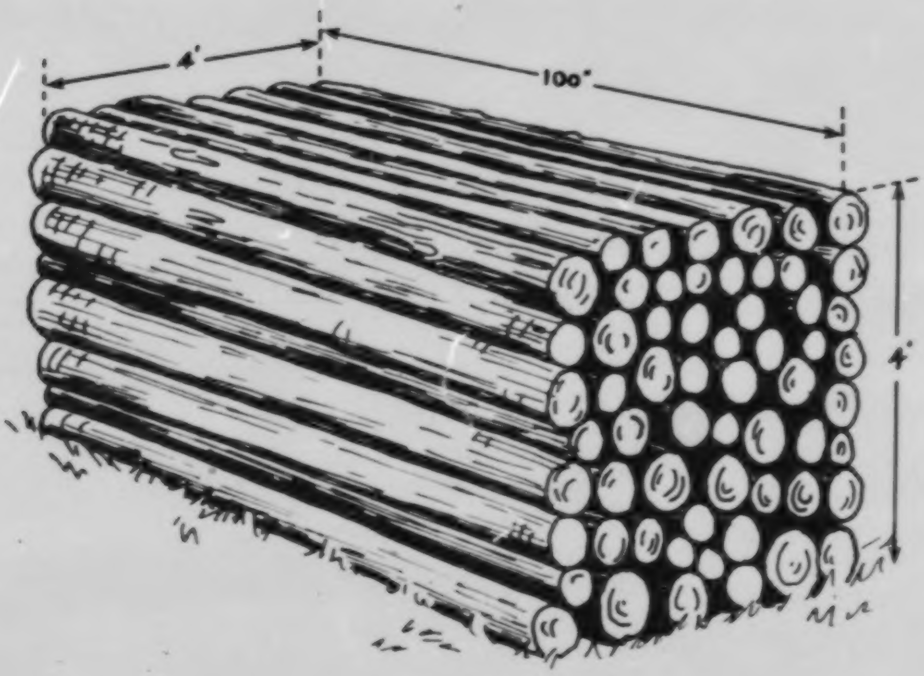


Table 2
CORDWOOD VOLUME FOR TREES
(from Technical Note 241 - Lake States Forest Experiment Station)

Diameter Breast High (DBH) Inches	8' (1 stick)*	16' (2 sticks)	24' (3 sticks)	32' (4 sticks)	40' (5 sticks)	48' (6 sticks)
	Tree Volume in Cords					
6	.02	.03	.04	.06		
8	.03	.05	.07	.09	.12	.14
10	.05	.07	.10	.13	.17	.20
12	.07	.10	.14	.18	.22	.27
14	.10	.13	.18	.23	.29	.35
16	.12	.17	.22	.29	.36	.44

Standard Cord is 4' x 4' x 8'. To find approximate volume of peeled wood, subtract 12 per cent.

Steps

1. Obtain diameter and usable height.
2. Consult table for volume of tree.
3. Add the volume for all tallied trees for the gross volume of area cruised.

---

*Note: The terms stick and 8 foot bolt are synonymous.

Table 3
CONVERSION FACTORS FOR CUBIC MEASUREMENT OF WOOD PRODUCTS

Unit of Measure	Board Feet 1/	Cubic Feet 2/	Cords	Cunits 2/	Cubic Meters 2/
One Board Foot 1/	1	.1886792	.0023883	.0018868	.0053428
One Cubic Foot	5.3	1	.0126582	.01	.0283168
One Cord (4x4x8)	418.7	79	1	.79	2.2370309
One Cunit	530	100	1.2658228	1	2.8316847
One Cubic Meter	187.1677335	35.3146667	.4470211	.3531467	1

1/ For 14" DBH trees. (Scribner DEC C Log Rule, board foot per cubic foot ratio increases as tree size increases and ranges from 4.4 board feet per cubic foot for 10" DBH trees to 6.2 board feet per cubic foot for 24" DBH trees.)

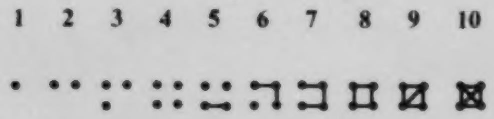
2/ Cubic feet, Cunits, and Cubic Meters are units of measure for solid wood excluding bark and air space. A cunit is a 100 cubic feet of wood.

hits the ground. This is one pace. Count only when your left foot touches the ground. This will give you the total paces you need to walk the 66 feet.

The average person takes about 12 paces for the 66-foot distance, but this will vary according to your *natural* stride, the topography and the amount of vegetation that you pace through.

Tallying Trees on Timber Cruiser Form

You can keep track of each tree you measure for D.B.H. and height by a simple *dot-dash* system. This will enable you to keep a neat and readable record of your field work even though writing space is limited and your pencil gets a bit dull.



The Tree Volume Table.

Since the forms of trees are extremely variable, as influenced by differences in tree species, the rate at which they grew, and the degree to which they were crowded while growing, there are literally hundreds of tree volume tables. The volume table printed on this stick represents an average table for trees whose usable stems contain 78 per cent of the volume of a cylinder having a length equal to the usable length of the tree, and a diameter equal to the diameter of the tree.

Using the Tree Volume Table (Table 4.)

Let us assume you have measured the diameter of a tree at breast height (DBH) and found it to be 20 inches, and that in estimating the height you determined it had a merchantable length of 48 feet, or three 16-foot logs if utilized to a top diameter of eight inches. You now want to get the volume in board feet. On the scale below "Diameter of Trees—in Inches" you will note volumes by

Table 4
COMPOSITE VOLUME TABLE FOR STANDING TREES
(from U.S. Forest Service Administrative Handbook)

Tree Diameter in Inches	Volume - Board Feet - Scribner Rule - by No. of Usable 16-foot Logs				
	1	1-1/2	2	2-1/2	3
10	28	36	44	48	52
11	38	49	60	67	74
12	47	61	75	85	95
13	58	76	94	107	120
14	69	92	114	130	146
15	82	109	136	157	178
16	95	127	159	185	211
17	109	146	184	215	246
18	123	166	209	244	280
19	140	190	240	281	322
20	157	214	270	317	364
21	176	240	304	358	411
22	194	266	338	398	458
23	214	294	374	441	508
24	234	322	409	484	558
25	258	355	452	534	617
26	281	388	494	585	676
27	304	420	536	636	736
28	327	452	578	686	795
29	354	491	628	746	864
30	382	530	678	806	933

Steps

1. Obtain diameter and usable height.
2. Consult table for volume of tree.
3. Add the volumes for all tallied trees for the gross volume of area cruised.

diameters of trees containing one, two, or three 16-foot logs. Since our tree had an estimated 48 feet of merchantable length, we would refer to the volume under 20 inches for a three-log tree, which gives a gross volume of 364 board feet. For trees with one and one-half, two and one-half, or three and one-half log length, volume is determined by interpolation. For example, a tree 20 inches DBH, containing one and one-half logs merchantable length (24 feet) will have a gross volume of...

$$\frac{157 + 270}{2}$$

...or 214 board feet. Note that 157 feet is the volume of a one-log tree; 270 feet is the volume of a two-log tree, 20 inches in diameter. It should also be noted that the volume table is constructed for trees shown at two-inch intervals in diameter. This is satisfactory when large numbers of trees are measured, and the diameters are rounded off to the nearest even number. In like manner, the volume of a tree with an odd numbered diameter can be had by averaging the volumes of trees in the even numbered diameters preceeding and following. Hence, a 19-inch three-log tree will have a volume equal to 280 + 364 ÷ 2, or 322 board feet. (Table 4 includes volumes for odd numbered inches of diameter and half logs. Some volume tables do not.)

Composition of Log Rules and Volume Tables

It is well to emphasize the fundamental differences between a log rule (regardless of name) and a volume table:

1. A log rule gives board foot volumes of *logs* only; a volume table gives board foot, and may give cubic foot or cordwood content of *standing* trees.
2. The diameter column in a log rule refers to diameter at the *small end* of a log; the diameter column in a volume table refers to the diameter at breast height of a standing tree.
3. The several columns indicating lengths in a log rule refer to length of logs; in a volume table these columns refer to usable lengths of trees, generally in terms of 16-foot logs.

Estimating Volumes

An inventory of the forest is obtained by measuring a portion of the forest using selected sample plots. Plots can be of three types.

1. Fixed Radius
2. Variable Radius
3. Permanent Sample Plots

Fixed Radius Plots

Fixed radius plots can be of any size. i.e. 1/10 acre, 1/5 acre, 1/4 acre.

Plot Size	Radius
1/10 acre	37.2 feet
1/5 acre	52.7 feet
1/4 acre	58.9 feet

The 1/10 acre and 1/5 acre plots are most commonly used.

Sample plots should be located so as to cover all the timber types or condition classes in the woods being assessed. Place the plots in the different types in numbers proportionate to the size of the area covered by the type.

Example:

Assume a 40-acre woods with three timber-types. To achieve desired accuracy in this case, 10 percent of the area, four acres or 20 sample plots, each 1/5 acre in size, is to be measured. The three timber-types are oak-20 acres, aspen-10 acres, and pine-10 acres. Place 10 sample plots in the oak area and five sample plots in each of the other two areas.

Plot centers should be located on a map or aerial photo before going to the woods. Also, locate a starting point and record the distance and compass bearing from the starting point to the first sample plot center and each succeeding plot center. Plot centers are thus located in succession on the ground by compass bearing and pacing from a known point. This is done to avoid bias in locating plot centers.

Once a plot center has been located, all merchantable trees (sawlogs 12 inches or more in diameter and pulpwood six inches or more in diameter) are measured, diameter breast high and usable length, measuring trees in a clockwise direction around the plot center. Use a tape that is equal to the radius of the plot size and fasten it to the plot center to determine whether borderline trees are in or out of the plot.

The average volume per acre is determined from the plot volumes, then multiplied by the number of acres in the woods to obtain the total volume.

For most uses, sufficient accuracy will be achieved if the following rules-of-thumb are used in determining the number of plots to be measured in a particular woodland:

A. If the entire woods appear quite uniform with very little difference in the size or density, measure 5 percent of the total area in plots. If the woods are 20 acres in size, 5 percent of the area is one acre or five one-fifth-acre plots.

B. If the woods are only moderately uniform, measure 10 percent of the total area.

C. When the woods are distinctly not uniform in character, measure 20 percent of the total area.

In situations where greater than the usual accuracy is desired, the local forester will gladly calculate the number of plots required.

Variable Radius Plots
(Point Sampling)

In 1948, Walter Bitterlich of Austria described a new and very rapid method of determining basal area per acre by point-sampling. In 1952, L. R. Grosenbaugh and others translated and expanded on this method to make it applicable to forestry in this country. Once basal area is known, it can be correlated to tree and stand volumes.

Basal area, as applied to tree measurement, is the area in square feet of the cross section of a tree at breast height. The total area in square feet of the cross sections of all trees on an acre is referred to as "basal area per acre." Basal area per acre can be easily determined with the aid of several different instrument using Bitterlich's principle. Such instruments are the wedge prism, stick-type angle-gauge, Panama angle-gauge, Spiegel Relaskop and various improved gauges.

In using these instruments, a cruiser counts the number of trees around a sampling point whose diameters at breast height appear larger than the crossarm of the angle-gauge (Figure 15.) or that are not cut in two when viewed through a wedge prism (Figure 16.). When the tree count is multiplied by a predetermined factor (basal area factor), the basal area per acre is obtained around the sampling point. A number of points must be taken and averaged to obtain basal area and volume estimates.

It is recommended that instruments used in timber stands of Wisconsin have a basal area factor of 10. With a factor of 10, the ratio of width of crossarm to length of stick (angle-gauge) or the displacement by the wedge prism is 1:33. That is, a tree one foot in diameter would be counted as an "in" tree up to 33 feet from the point center. In all references to the basal area factor in this exercise, the factor will be assumed to be 10.

The probability of a tree being counted as "in" is proportionate to its size (Figure 17). A tree twice the diameter of another and at the same distance from the point center has four times the probability of being counted as would the smaller. Larger trees, which are more variable in volume and quality, are sampled in greater proportion than smaller trees which are less variable and of less importance.

Figure 15
POINT SAMPLING WITH ANGLE GUAGE

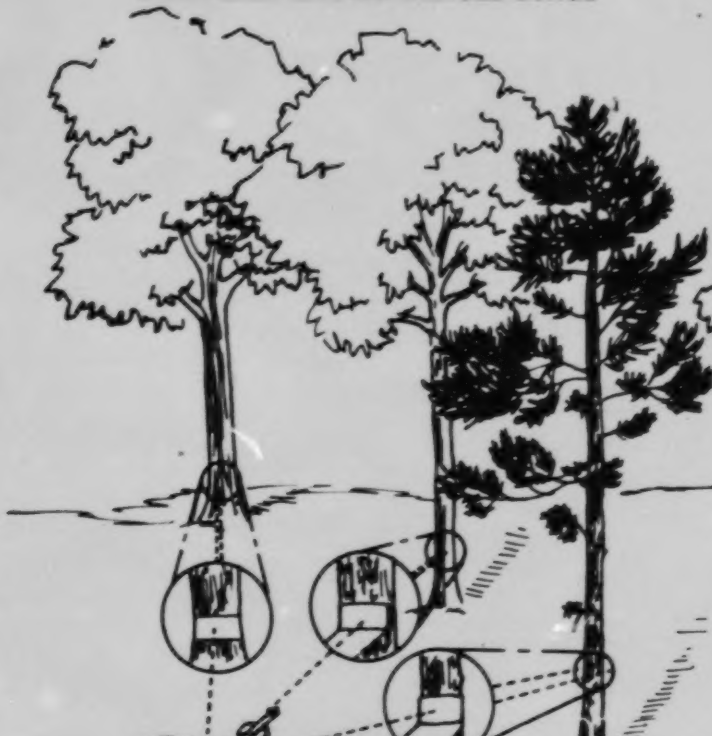


Figure 16
POINT SAMPLING WITH WEDGE PRISM

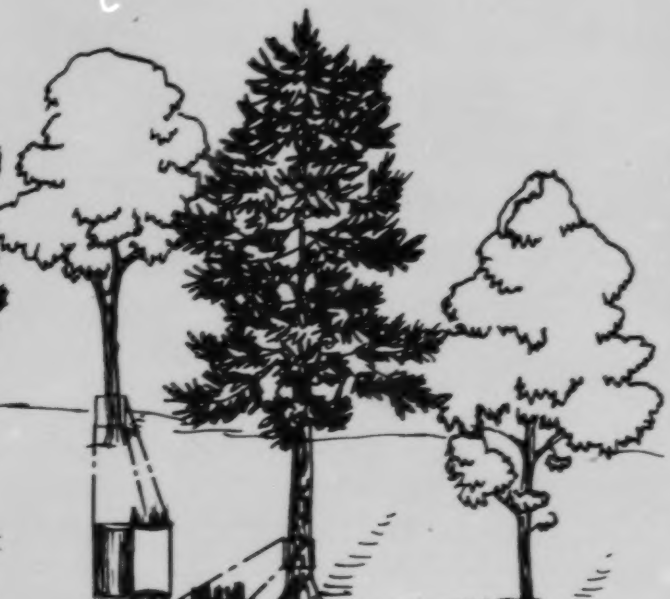
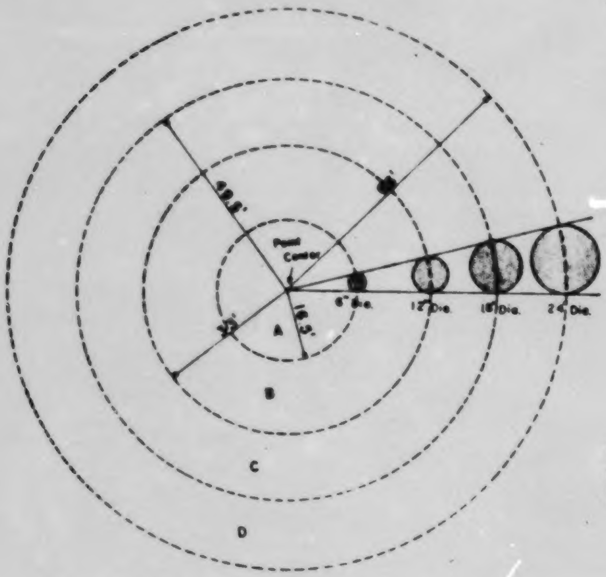
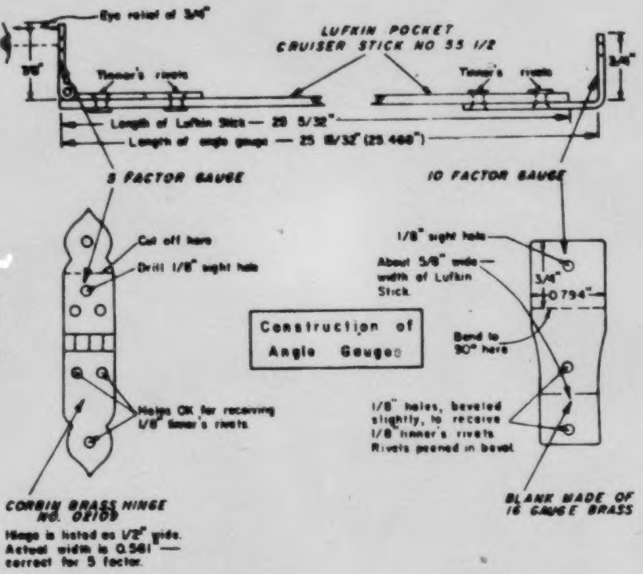


Figure 17
RELATIONSHIP BETWEEN TREE DIAMETER AND PLOT DISTANCE. BAF 10


48.6'
Point Center
16.5'
32.?'
6" Dia.
12" Dia.
18" Dia.
24" Dia.
A
B
C
D

Relationship between tree diameter and "plot" distance. BAF 10.

Figure 18
CONSTRUCTION OF ANGLE GAUGE


Eye relief of 3/4"
3/4"
LUFKIN POCKET CRUISER STICK NO 55 1/2
Tinner's rivets
Tinner's rivets
3/4"
Length of Lufkin Stick — 25 5/32"
Length of angle gauge — 25 15/32" (25.468")
5 FACTOR GAUGE
10 FACTOR GAUGE
Cut off here
Drill 1/8" sight hole
Holes OK for receiving 1/8" tinner's rivets
CORBIN BRASS HINGE NO. 02109
Hinge is listed as 1/2" wide. Actual width is 0.561" — correct for 5 factor.
Construction of Angle Gauges
1/8" sight hole
About 5/8" wide — width of Lufkin Stick
3/4"
0.794"
Bend to 90° here
1/8" holes, beveled slightly, to receive 1/8 tinner's rivets. Rivets peened in bevel.
BLANK MADE OF 16 GAUGE BRASS

Computations for Gauge Widths

Total length of Bitterlich Stick	25.468"
Eye relief displacement	+0.750
Effective length of Bitterlich Stick	26.218

	Effective length	x	Width of gauge per 1" of stick	=	Gauge width
10 FACTOR WIDTH	26.218	x	0.0303	=	0.7944"
5 FACTOR WIDTH	26.218	x	0.0214	=	0.5611"

Construction of angle gauges.

Tomahawk 1962

Each counted tree represents 10 square feet of basal area per acre. It also represents a certain part of an acre and a specific number of trees per acre. A small tree represents a small area but a large number of trees. A large tree represents a large area but a small number of trees.

The use of the point-sampling system requires considerable care in the determination of "in" and "out" trees. The following precautions must be taken:

1. Be certain all trees are counted. Watch for the hidden ones.
2. Count only the merchantable trees. Do not count dead or cull trees.
3. Do not stray off point center.
4. Hold angle-gauge close to eye.
5. Hold wedge prism over point center in a vertical position and at right angles to the line of sight.
6. On steep slopes a correction factor must be applied. (Figure 19.)

This correction for tree count, basal area and volume per acre is true only when it is assumed that in this sampling procedure a proportionate number of trees will be added when the slope distance is corrected to the true horizontal distance.

Some rules of thumb for determining the number of points needed to give acceptable results are:

1. In sawtimber stands, use the same number of points as 1/5-acre plots.

Table 5
RELATIONSHIPS BETWEEN CROSSARM AND LENGTH OF ANGLE-GAUGE

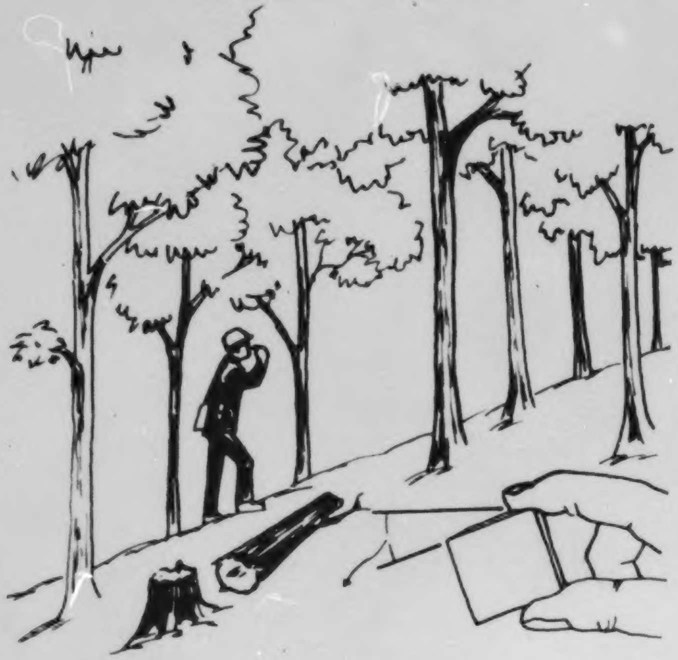
Width of Crossarm (Inches)	Length of Angle-Gauge—Inches		
	BAF 5	BAF 10	BAF 20
.25	11.67	8.25	5.83
.30	14.00	9.90	7.00
.35	16.33	11.55	8.17
.40	18.67	13.20	9.33
.45	21.00	14.85	10.50
.50	23.34	16.50	11.67
.55	25.67	18.15	12.83
.60	28.00	19.80	14.00
.65	30.34	21.45	15.16
.70	32.67	23.10	16.33
.75	35.00	24.75	17.50
.80	37.34	26.40	18.66
.85	39.67	28.05	19.83
.90	42.00	29.70	21.00
.95	44.34	31.35	22.16
1.00	46.67	33.00	23.33

BAF 5 has a ratio of 1/46.67; therefore length of stick is 4.667 inches per .1 inch of crossarm.

BAF 10 and 20 have ratios of 1/33 and 1/23.33; therefore length of stick is 3.300 inches and 2.333 inches per .1 inch of crossarm, respectively.

48

Figure 19
CORRECTING FOR SLOPE



2. In pole-timber stands use at least twice as many points as 1/5-acre plots.

To use this method in determining pulpwood volumes, the cruiser counts the total number of pulpwood sticks in all "in" trees, adds to this the total number of "in" trees and divides this sum by two. This represents the total number of cords per acre. In sawtimber estimating, the cruiser counts the number of 16-foot logs in all "in" trees. He multiplies the total number of logs by 600 to obtain the gross board-foot volume per acre. (For average hardwood stands.)

The volumes per acre of point sampled are averaged. This, multiplied by the total acres in the stand, will give the total volume of the stand.

Table 6
BASAL AREA SPACING GUIDE

(From U.S. Forest Service Timber Management Field Book, Region 9)

DBH Inches	Square Feet of Basal Area per Acre									
	40	50	60	70	80	90	100	110	120	140
	Square Spacing to Nearest Foot									
2	5	4	4	4	3	3	3	3	3	3
3	7	7	6	6	5	5	5	4	4	4
4	10	9	8	7	7	6	6	6	6	5
5	12	11	10	9	9	8	8	7	7	7
6	15	13	12	11	10	10	9	9	8	8
7	17	15	14	13	12	11	11	10	10	9
8	19	17	16	15	14	13	12	12	11	10
9	22	20	18	17	16	15	14	13	13	11
10	24	22	20	18	17	16	15	15	14	13
12	29	26	24	21	21	19	18	18	17	16
14	34	31	28	26	24	23	22	21	20	18
16	39	35	32	29	28	26	25	24	24	21
18	44	39	36	33	31	29	28	26	25	23
20	49	44	40	37	34	32	31	29	28	26

The Basal Area Spacing Guide provides a convenient method of estimating basal area if average tree diameter and spacing between trees is known.

Permanent Sample Plots

Periodic remeasurements of identical trees in a permanent sample plot are the most reliable means by which the influences of improvement cuttings and harvest operations on the growth rates of remaining trees can be determined. Two initial steps are involved, and these may be worked on as laboratory exercises over a period of time, especially in demonstration or school forests where thinnings have been made.

1. Lay out one or more 1/5-acre sample plots, determining and recording carefully the exact location of the plot center of each, so that it may be easily relocated for future measurements.
2. Record diameter and merchantable height measurements of all trees, on a permanent sheet, for each tree in the plot. This sheet should provide room for recording future remeasurements of the same tree, as well as smaller trees which have in the meantime reached the minimum diameter for plot measurement purposes. When plot trees grow into this minimum size, the added growth is reported as "in-growth."

Equipment Needed

1. A flat board, or plane-table, set on tripod.
2. A circular plot diagram, printed on paper (Figure 20) for each permanent plot.
3. Sheet for permanently recording tree measurements, in numbered sequence, or indicated on the plot diagram.
4. Tape or rope 52.7 feet long, to establish radius of plot at several points on circumference.
5. A tape measure, or a forester's diameter tape, to make accurate diameter measurements at breast height.
6. A staff or small pole 4 1/2 feet long, to insure measurements uniformly at this height on tree trunks.
7. Tape for measuring distances of plot trees from center hub.
8. Alidade or sights for accurately indicating line of sight of each plot tree from the hub, and for accurate location on plot diagram.
9. Hand compass for aid in describing bearing of line leading to plot, and for orienting plot diagram.

The plane table with the plot diagram on it should be placed over the plot hub or center. Orient the plot diagram so that the top of the sheet is facing north. Trees should be measured clockwise from the north. Measurements will be taken essentially the same as in the exercise on methods of forest inventory, except that measurements of diameter should be recorded to the nearest tenth of an inch. Later measurements may reveal that smaller trees have grown to this size. These should then be given numbers on the plot diagram, and measurements of them recorded on the sample plot enumeration sheet. (Table 7.) A plot diagram sheet similar to that shown in Figure 20 can be reproduced for your use.

Volume measurements for each plot can be calculated as described in the section on fixed radius plots.

Figure 20
PERMANENT SAMPLE PLOT

PROJECT School Forest PLOT NO. 1 FORTY NO. ______
LOCATION (Based on compass line and distance - record) TYPE & DENSITY ______
AGE ______ DATE ______ 19__ PARTY ______
REMARKS ______ ______ 19__ ______
______ ______ 19__ ______
______ ______ ______

LARGE CIRCLE RAD. 52.7' 1/5A. SMALL CIRCLE RAD. 37.2' 1/10A.

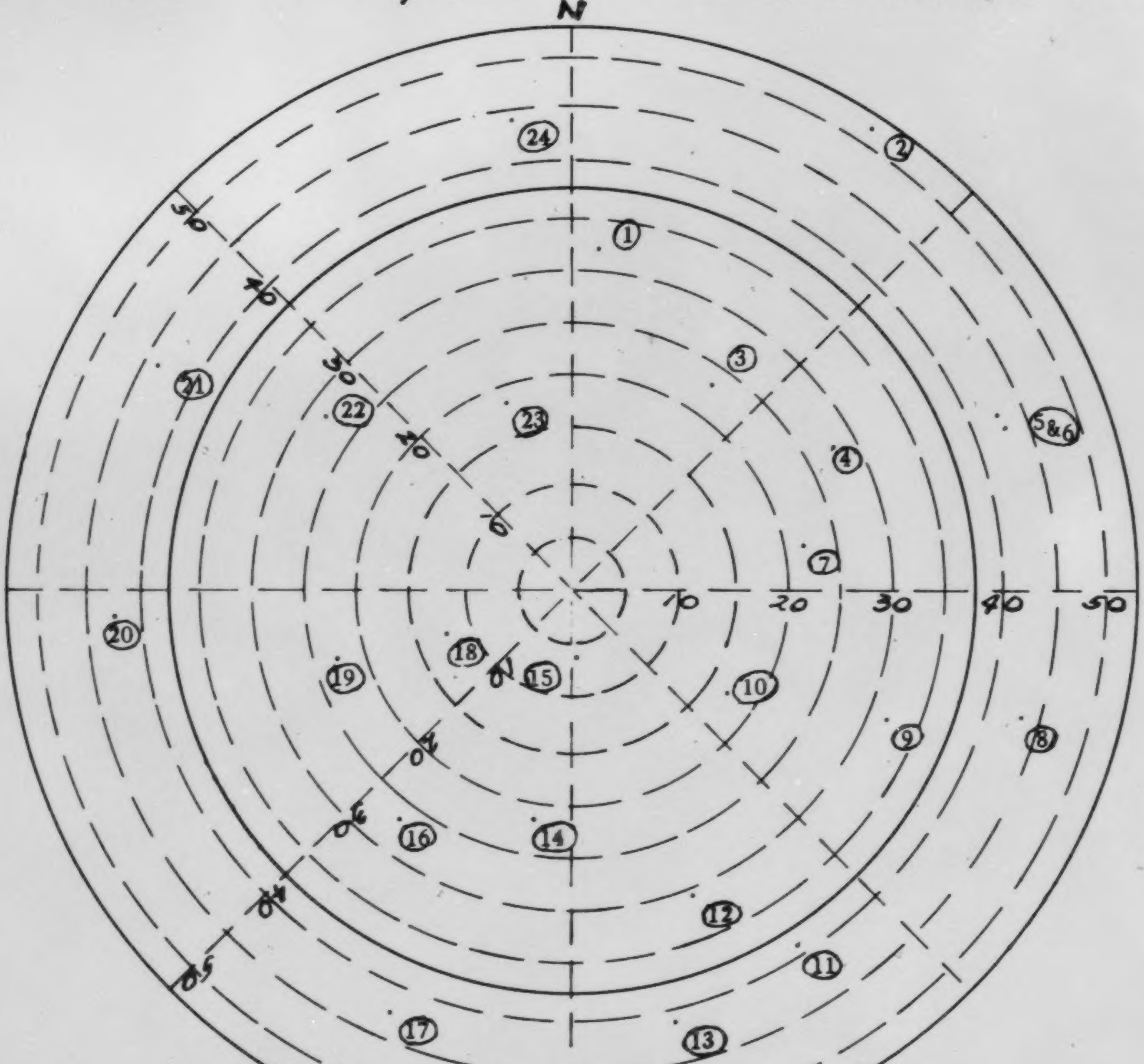

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Table 7
PERMANENT SAMPLE PLOT ENUMERATION SHEET
(Sample Sheet to be duplicated by instructor)

Project:
Plot Number: 1
Radius of Plot: 52.7′

Dates Measured:____________________
Measured by:____________________
Tallied by:____________________

Tree Number	Species	D.B.H. inches Year Measured		Usable Height-Feet Year Measured		Remarks
		19—	19—	19—	19—	
1.	White Oak	17.3		32		
2.	White Oak	11.1		16		
3.	Red Oak	21.6		40		
4.	Hard Maple	13.8		24		
5.	Basswood	20.1		48		Twin sprouts
6.	Basswood	17.8		40		Twin sprouts
7.	Red Oak	17.7		32		Large fork
8.	White Oak	12.4		16		
9.	Hickory	10.6		8		
10.	Red Maple	13.0		16		
11.	Basswood	16.7		32		
12.	Elm	18.1		40		Large Fork
13.	White Oak	14.4		24		
14.	White Oak	10.0		8		
15.	Hard Maple	21.1		48		
16.	Red Oak	14.0		24		
17.	Red Oak	19.4		40		

Methods of Finding Growth Rates

The rate of growth of individual trees is largely controlled by age, species, site quality and proximity to surrounding trees. The factors which affect the growth rate of individual trees determine the growth of forest stands. To attain maximum growth of a stand, the stand must approach a fully-stocked condition where trees have adequate room to grow and where there is a maximum number of trees upon which growth can take place.

Trees grow in both diameter and height. Repeated measurements of these two variables at five or ten year intervals can provide accurate estimates of growth during the period between measurements. The difference in volume of the tree or stand at the time of the two measurements can be expressed as either annual or periodic growth.

Past growth rates are most often used to evaluate the rapidity of growth in an individual tree and also as a means of predicting future growth of entire stands. Growth of the individual tree may be used to indicate its growth rate as compared to other trees in the stand and indirectly its maturity or desirability as future growing stock. Growth of the entire stand can be used as a rough guide in setting allowable cut.

Growth rate of an individual tree is evaluated on the basis of the width of the annual rings and on changes in its merchantable height. Diameter measurements are made at four and one-half feet from the ground, diameter breast height (D.B.H.), with the use of an increment borer; or by counting and measuring the annual rings on the stump. Height may be measured as in the case of a felled tree or estimated in a standing tree.

Growth of a forest stand is expressed in board feet, cords or any other common forest unit of measurement and may be indicated as a percentage of the original volume. Growth in a forest stand is often considered to have two basic elements: growth of the merchantable trees; and growth of trees which are approaching merchantable size ingrowth. Only the better trees considered to be desirable growing stock—are used either to predict growth of the stand or as sample trees.

Growth in the forest stand is usually predicted on the basis of sample tree measurements taken in the process of making a timber inventory. It is common practice to measure one or two such trees on each inventory plot.

The diameter of sample trees is measured at D.B.H. with a diameter tape or cruiser stick. The merchantable height is measured or estimated and an increment core is taken and measured. In the sample growth calculation which follows, the number of rings in the last inch of radial growth is used. Other growth prediction systems use measurement of the radial growth during the past ten or twenty years.

It is very desirable that sample trees be selected in proportion to the acreage and number of trees in various conditions in the forest. This is essential in order to eliminate bias in the sample. When various portions of a forest tract are sampled at different intensity or with recognized variability, the sample trees for each portion thus recognized should be segregated and computed separately. An alternative would be to weigh the sample on the basis of the acreage or number of good growing stock trees found in each tract.

If growth data is desired, use and increment borer to obtain one core per plot or point. Record the D.B.H. of the tree and the number of inches the radius grew in the last 10 years. Select the best tree which is nearest the plot or point center. Then follow the ratio of basal area growth calculation outlined below. This gives growth increase in percentage for the past 10 years. The same percentage increase can be assumed for the next 10 years.

Shown below is the development of a growth formula based on increment and basal area. This is followed by a table for use in calculating growth with an example illustrating its use.

Growth Assumptions are Based on —

$$(1)\ \frac{\textbf{Past B.A. Increment}}{\text{Present B.A.}} = \frac{\textbf{Future B.A. Increment}}{\text{Present B.A.}}$$

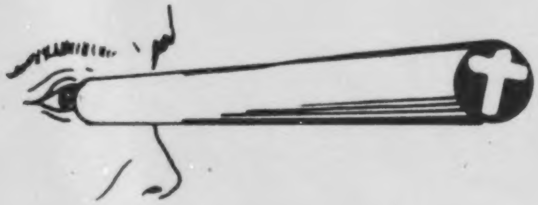
$$(2)\ \frac{\textbf{Present Volume}}{\text{Present B.A.}} = \frac{\textbf{Future Volume}}{\text{Future B.A.}}$$

The Average Ratio of Basal Area Increment to Basal Area per Acre is:

$$ROB = 1 - \frac{\frac{dbh^2}{DBH^2}}{n}$$

dbh = Past Diameter Breast High
DBH = Present Diameter Breast High
n = Number of Growth Sample Trees
dbh = DBH - 2r
r = 10-year Radial Growth in Inches

Figure 21
PANAMA ANGLE-GUAGE



Scaling Cut Products

By definition, scaling is the term used in estimating the lumber content of a log or a group of logs considered together, based on a specific log rule. It is a system of measurement of forest products.

Logs

Logs or timber intended for sawing into boards, planks or other construction materials are known as sawlogs. In Wisconsin, the more important species are elm, maple, oak, basswood, walnut, ash, yellow birch, white and red pine, and hemlock. Trees to be cut for sawlogs should be straight, sound, and at least 16 feet to the nearest branch. After a tree is felled, it is usually cut into 8-, 10-, 12-, 14-, or 16-foot lengths plus an additional 4 to 6 inches for trimming and squaring the ends of the resulting board. Knowledge of the length desired by the ultimate user is essential before felled trees are cut. The board-foot content or scale of a log is determined by measuring the average diameter inside the bark at the small end of the log in feet, and referring to a table indicating the board feet. A board foot is equal to a piece of wood 12 inches wide x 1 inch thick x 1 foot in length.

In Wisconsin, the Scribner Decimal C scale is used in measuring logs cut from the national state and county forests. Walnut logs are usually scaled on the "Doyle Rule" which has inaccuracies when applied to small logs.

The International Rule is the most accurate rule devised but, unfortunately, it is not widely used. The figures given will come quite close to the actual board feet obtained by most sawmills in operation in the state.

When many logs are measured, scale sticks giving direct readings in board feet using the desired log rule, such as Scribner, International or Doyle, are often used. If logs are defective, the board-foot contents are reduced accordingly.

Posts, Poles and Pilings

Material used for these purposes are usually sold by the piece. The standard unit of measure is the linear foot. Sizes for the various products vary, depending use. Posts, used for fencing, are usually 5 to 7 feet in length and 3 to 8 inches at the small end. Piling-size range is 15 to 60 or more feet in length and between an 8-inch tip and 20-inch butt.

Poles used in utility work have a length requirement of 30 to 45 feet and a diameter inside bark at the small end ranging 5 to 7 inches.

In most cases, the product is scaled or measured as to length in feet and diameter inside bark at the small end.

Cordwood

In four principal markets, the cord is used as the standard unit of measurement, but a cord may have a number of different sizes in these major market products. Briefly, they are these:

Table 8
BOARD FOOT CONTENT OF LOGS
Length of Log in Feet

Diameter inside bark small end (inches)	Scribner decimal C. rule (in tens) [1]/						Doyle rule[2]/					International rule[3]/				
	6	8	10	12	14	16	8	10	12	14	16	8	10	12	14	16
	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.
6	0.5	0.5	1	1	1	2	2	3	3	4	4	10	10	15	15	20
7	.5	1	1	2	2	3	5	6	7	8	9	10	15	20	25	30
8	1	1	2	2	2	3	8	10	12	14	16	15	20	25	35	40
9	1	2	3	3	3	4	13	16	19	22	25	20	30	35	45	50
10	2	3	3	3	4	6	18	23	27	32	36	30	35	45	55	65
11	2	3	4	5	5	7	25	31	37	43	49	35	45	55	70	80
12	3	4	5	6	7	8	32	40	48	56	64	45	55	70	35	95
13	4	5	6	7	8	10	41	51	61	71	81	55	70	85	100	115
14	4	6	7	9	10	11	50	63	75	88	100	65	80	100	115	135
15	5	7	9	11	12	14	61	76	91	106	121	75	95	115	135	160
16	6	8	10	12	14	16	72	90	108	126	144	85	110	130	155	180
17	7	9	12	14	16	18	85	106	127	148	169	95	125	150	180	205
18	8	11	13	16	19	21	98	123	147	172	196	110	140	170	200	230
19	9	12	15	18	21	24	113	141	169	197	225	125	155	190	225	260
20	11	14	17	21	24	28	128	160	192	224	256	135	175	210	250	290
21	12	15	19	23	27	30	145	181	217	253	289	155	195	235	280	320
22	13	17	21	25	29	33	162	203	243	284	324	170	215	260	305	355
23	14	19	23	28	33	38	181	226	271	316	361	185	235	285	335	390
24	15	21	25	30	35	40	200	250	300	350	400	205	255	310	370	425
25	17	23	29	34	40	46	221	276	331	386	441	220	280	340	400	460
26	19	25	31	37	44	50	242	303	363	424	484	240	305	370	435	500
27	21	27	34	41	48	55	265	331	397	463	529	260	330	400	470	540
28	22	29	36	44	51	58	288	360	432	504	576	280	355	430	510	585
29	23	31	38	46	53	61	313	391	469	547	625	305	385	465	545	630
30	25	33	41	49	57	66	338	423	507	592	676	325	410	495	585	675

In the eastern United States the board Foot contents of logs are measured by one of three different log rules or scales.

[1]THE SCRIBNER RULE is based on diagrams which intend to show the actual board feet that can be sawed from logs of varying lengths and diameters.

The original rule was published over a century ago, but subsequently the last digit was dropped and the figures rounded off to the nearest 10 board feet. The rule is in general use in Wisconsin and Minnesota and in national forests. It is now known as "Decimal C" as given above.

[2]THE DOYLE RULE is based on the formula $\frac{(D-4)^2}{4} L =$ Board feet, in which D is the diameter of the small end of the log, inside the bark in inches, and L is the length in feet. In spite of its inaccuracies when applied to small logs, this rule is used almost exclusively in scaling hardwoods of the Mississippi and Ohio Valleys, and in the southern pine region. It underscales average-sized logs by about 30 board feet.

[3]THE INTERNATIONAL RULE is the most accurate rule yet devised but unfortunately does not have the widespread use of the others. The figures given will come quite close to actual board feet that can be derived from sound logs by saws which cut 1/4 inches of kerf (saw-dust). It has been adopted by statute in Michigan. The formula, .8D(D-2) will give values closely approximating the board feet in 16-foot logs.

*Taken from Forestry Handbook for Upper Mississippi Region. U.S. Soil Conservation Service

Fuelwood

The *standard* fuelwood cord consists of sticks of wood **four** feet long, piled neatly into a stack of wood **four** feet high and **eight** feet long. This represents a gross cubic foot volume of 128 cubic feet. Often, wood is sold on the basis of a **short** cord for fuel. This is exactly one-third of a standard fuel-wood cord, and the sticks are 16 inches long.

Pulpwood

The standard pulpwood cord is composed of bolts, or logs, 100 inches long, placed in a pile **four** feet wide and **four** feet high. This represents a gross cubic volume of 133 cubic feet. There has been a trend in recent years to peel the bark from certain pulpwood species. In scaling bark-peeled pulpwood, a conversion factor of 12-1/2% is added for hand-peeled wood and 25% for machine-peeled. This means, for example, that a machine-peeled pile of wood scaling 12 cords would be paid for on the basis of 15 cords of rough wood.

Excelsior

The bolts of wood used in an excelsior plant are 55 inches long. To make a cord, these bolts are compactly assembled in a pile or rick **four** feet high and **eight** feet long.

Box Board Bolts

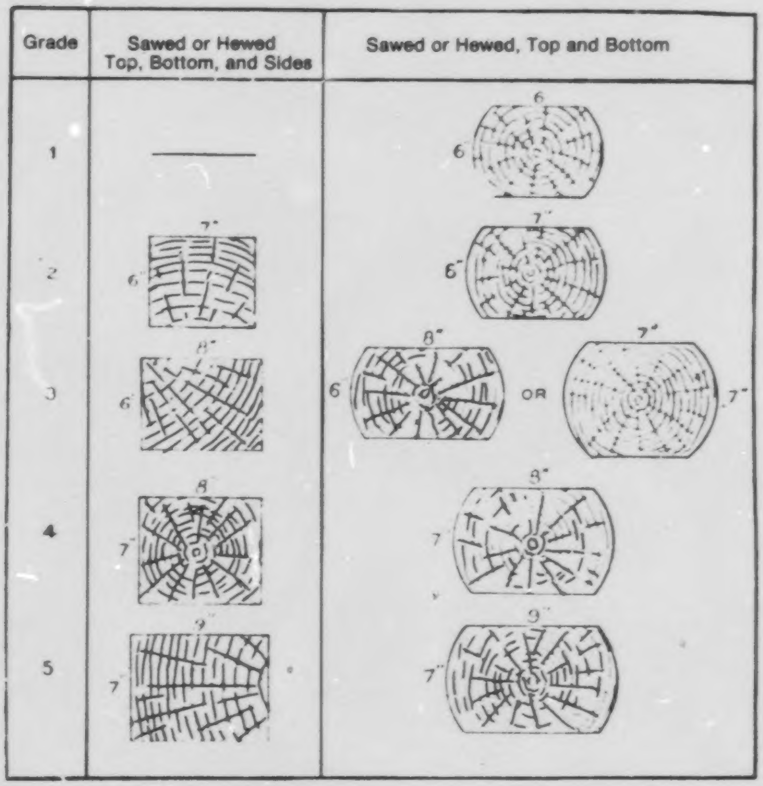
There is a wide range in the lengths of bolts purchased by mills. Often, the bolts are the same length as pulpwood and therefore, a cord would have the same dimensions. When they range in length from 36 inches to 50 or more inches, the cord represents a rick or pile of bolts the same length and same height as for excelsior bolts — **four** feet by **eight** feet.

Railroad Tie Logs

There are five major railroad tie sizes as related to width and thickness, but the standard length is **eight** feet. Study the diagram showing the crosssection measurements of sawed ties, and ties which are slabbed, or sawed, on only two surfaces. Note that size one represents the tie with the smallest dimensions, and size five represents that with the largest.

The minimum standard railroad tie length is 8-feet, although some railroads demand 8 1/2-feet or 9-feet ties. The minimum diameter of a tie cut is about 8 to 9 inches outside the bark at the small end. Logs produced for

Figure 22
STANDARD SPECIFICATIONS FOR CROSSTIES


Grade
Sawed or Hewed Top, Bottom, and Sides
Sawed or Hewed, Top and Bottom
1
2
3
4
5
6
6
7"
6
7"
6"
8"
6
8"
6
OR
7"
7"
8
7"
8"
7
9"
7
9"
7"

railroad ties are usually scaled in a similar manner with other sawlogs. The diameter inside bark at the small end of the log is determined plus the length. The volume of wood is determined from a log scale table. Tie logs can either be sold by the piece or on a thousand-board-foot basis.

Stave Bolts (Cooperage)

Stave bolts are utilized in two ways — as slack cooperage or tight cooperage, depending on whether the resulting barrel is to be used for dry material or liquid.

White oak is the Wisconsin species used for tight cooperage. Sections of varying length, usually between 30 to 39 inches depending upon the kind of barrel, are cut from sound, straight-grained trunks of trees 18 inches or more in diameter, 4 1/2 feet from the ground. The sections are then split radially to the size acceptable to the local market 6 inches being the smallest size taken. The resulting bolts are measured by the cord-foot (sometimes called "bolt-foot"). Payment is made on the basis of so much per cord-foot. Splitting the stave bolts requires considerable skill to obtain the most efficient utilization. "Do-it-yourself" loggers are not encouraged to split stave bolts unless they are thoroughly familiar with the operation.

If disposal of trees as stumpage is contemplated, the owner should carefully consider the values offered for staves against prices obtainable for veneer or high-grade sawlogs, keeping in mind that there is an enormous amount of waste in trees (usually 50-70 percent) if only barrel staves are taken.

Some of the other forest products have unique measurements: maple syrup by the gallon with the specification of 11 pounds of weight in a "standard" gallon. Christmas boughs are measured by weight.

Log Grading Specifications

The most common log grading systems used in the north central region are found in the forest products laboratory's *Hardwood Log Grades for Standard Lumber* (Pocket Edition D1737-A), Madison, Wisconsin; the Northern Hardwood and Pine Association's *Official Grading Rules for Northern Hardwood and Softwood Logs and Tie Cuts*, Suite 207 Northern Building, Green Bay, Wisconsin; the Ohio Forestry Association's *Standard Sawlog Grades*, Southern Hotel, Columbus, Ohio; the Purdue University's *Hardwood Sawlog Grades*, Purdue University, Department of Forestry, Lafayette, Indiana; and the American Walnut Manufacturers Association's *Rules for Grading American (Black) Walnut Logs*, 666 North Lake Shore Drive, Chicago, Illinois. Pocket editions can be obtained by contacting the various associations.

Use Classes

It must be recognized that all hardwood logs of better than the minimum specifications are not adaptable to the production of items with similar use requirements. Consequently, the many factors influencing log quality can be isolated and their effect gauged only if use is taken into consideration. Presently, three log-use classes appear to be adequate to cover current hardwood utilization practices:

1. *Factory Class.* A log basically adaptable to the production of lumber that later will be recut into smaller pieces. It should be free from blemishes and imperfections. The grade of such lumber is determined by specifications of the official National Hardwood Lumber Association grading rules for standard lumber. These control the number and minimum size of such defect-free pieces to be cut from the original board of a given grade. The technical bases for the grading class are the clear face and the sound cuttings. High-grade boards are those which will yield percentages of clear-face cuttings with individual cuttings relatively large. Low-grade boards are those which will yield low percentages of clear face, or sound cuttings, with individual cuttings being relatively small.

2. *Construction Class.* Logs adapted to the production of ties, timbers and other items to be used, more or less intact, for structural or weight-bearing purposes. Grade specifications are contained in the construction-lumber section of the National Hardwood Lumber Railway Association, as are the standard specifications of the American Society for Testing Materials for structural wood joists, planks, beams, stringers, posts and timbers. In general, these specifications are designed to control strength. In typical logs suitable for this use, the position and condition of the heart area are especially important. Knots and other defects which would impair the strength of products are limited to sizes which hold impairment within satisfactory limits.

Although factory-lumber grades allow for progressively more defects from the high grades to the low grades, *construction* specifications are rigid throughout with regard to the inclusion of imperfections that may cause weaknesses in the lumber. Such specifications, result in log requirements different from those for factory lumber use. For example, a factory log with a rotten, shaky interior, and large, widely-spaced individual log defects, will often produce enough high-grade high-quality boards. Such a log would be practically worthless as a construction log.

3. *Local Use Class.* Local-use logs are generally suitable for products not usually covered by any standard specifications. High strength, great durability, or fine appearance are not required in these products. They are usually sold in local or restricted markets for use in secondary farm buildings, crating, mine ties, and industrial blocking. Whereas the products of the other two classes, are usually sold over a wide area, through a variety of marketing channel. Local use materials are generally sold directly to the user. This situation often makes the handling of local-use logs quite profitable.

This system of log-use classification allocates any log to an arbitrarily selected class to which it is naturally adapted. The factory class is probably the highest value class, but the allocation of a log to it does not take into consideration its suitability for use in a lower class. The lowest economic class is local use. The logs suitable for local-use class are not suitable for construction use and cannot be economically manufactured into factory lumber. Most high-class logs can be, and often are, used for lower purposes. It is common to observe high-class logs being cut into ties or to see mills producing standard lumber from logs well-suited for timbers. Usually, at any lumber mill, logs unsuited for that particular purpose can be found. The reasons for these situations are complicated and not due entirely to a lack of understanding on the part of operators. One important reason is until now there have been no accepted specifications for these three classes of logs to guide operators in allocating logs to their most appropriate use.

4. *Other Products.* The question may arise as to the relation of quality factors to products other than lumber, timber and ties. It may appear that inadequate attention has been given to other products. The fact is although other products may assume considerable local importance, they are but a minor part in the overall picture of hardwood utilization. About 90 percent of all hardwood timber is cut into the products described. Specialty product specifications are usually closely related to those for factory lumber: relatively short, clear pieces of almost perfect wood, or veneer sheets with few defects desired. Limited studies of specialty products have shown that log quality can be gauged closely by the factory log class system.

Log Grading

The major objective of log grading is to separate from the woods-run logs those suitable for the manufacture of a given product or products (veneer, standard lumber, ties, etc.), and for each kind or class so separated, to determine the qualities of products obtainable from tree-bole segments with various characteristics

The grades are specified, however each processer may interpret them differently. A suggested grading system and examples follow in Figure 23 (Log Grades).

Suggested Learning Activities

1. Girdle undesirable trees
2. Measure D.B.H. with steel diameter tape.
3. Determine tree height with Hypsometer.
4. Layout 1/10 acre inventory plots.
5. Make a cruising stick to measure tree diameter and height.
6. Establish permanent plots for growth studies.
7. Measure log volume and cord volume.

* * *

Figure 23

LOG GRADES

With the cooperation of the Northern Hardwood and Pine Manufacturers Association.
The Scribner Decimal C Log Rule is used here as the Standard log rule.

Hardwoods

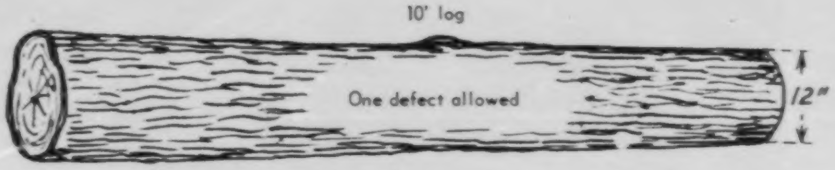
Grade No. 1 or Veneer Grade

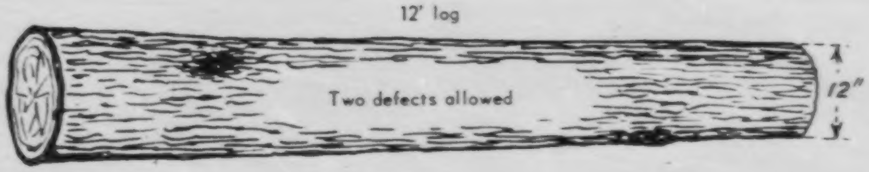
Diameter: All logs must be 12" or larger in average diameter, as measured from the small end inside the bark.

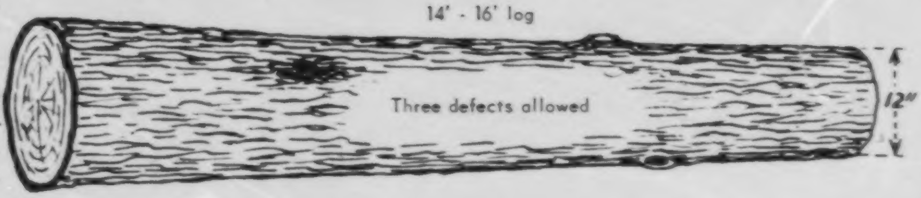
Length: Standard lengths are 8'6", 10'6", 12'4", 16'4" and 17'. Other lengths may be cut, optional with buyer. Note: 4" to 6" must be added to length for trimming allowance.

Quality: All logs must be cut from fresh, green timber. Diagrams indicate maximum number of standard defects allowed for various log lengths. Any number of defects located so that they can be cut out in one foot will be considered as only one defect.

Standard defects: Worm holes, knots, bumps, shake, cat faces, dead and dozy spots, bird pecks, brown spots, pin holes or specified seams are standard defects. Scale off one foot in length for each defect, except for center holes and seams allowed in this grade (see page 2).







Select Veneer Grade

Diameter: Logs must be 14" or larger in average diameter at small end inside bark.

Length: Standard lengths include 7'6", 8'6", 10'6", 12'4", 16'4", and 17'. All lengths are optional with buyer.

Quality: Select Veneer Grade must be free of all defects, except as provided for center hole defects in Grade No. 1. Logs must be straight. But, logs 14'4" and over may have a slight sweep provided one center cut will make two straight bolts.

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Defects in Veneer Logs

Center Rot or Hole: Logs 14" in average diameter may have a 3" hole, doze or shake in the heart; 15" in average diameter may have a 5" center defect, and 16" and over in diameter a 6" center defect. There is no deduction in scale for these defects. Logs 16" and over in diameter with center defects greater than allowable size are acceptable if such defects will be reduced to allowable size by deducting 2' from scaling length.

Seams: No seam is allowed in logs 15" or smaller in diameter. Logs over 15" are allowed one tight, straight seam (such as caused by lightning or frost), not deviating more than 4" from a straight line stretched from end to end of log. An allowable seam counts as one defect with no deduction in scale.

Sweep: All logs must be reasonably straight. Sweep up to 1/6 of diameter of small end is allowed in logs 10'6" and shorter, when measured above the butt swell.

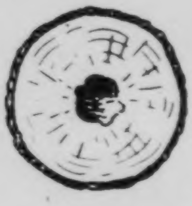
Spiral Grain: Allowed in not more than 1" in 10" of log length. Excessively curly grain will not be accepted in any veneer grades.

Butt Defects: Any defect in butt of log, such as fold, fluted bark, or shallow scar, not extending inside the diameter of the small end, will not be considered a grading defect. No scale deduction will be made. (Applies to all other grades.)

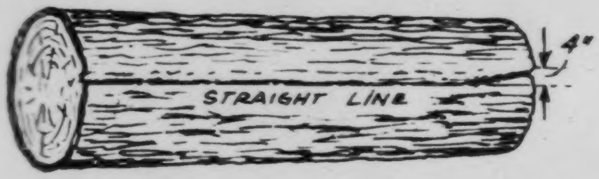
Crotches or Kinks: Crotches, crooks or kinks are to be scaled out when located so that a veneer log can be obtained.

Maple Stain: One half diameter of small end may be black heart or heavy mineral stain, with no deduction in scale.

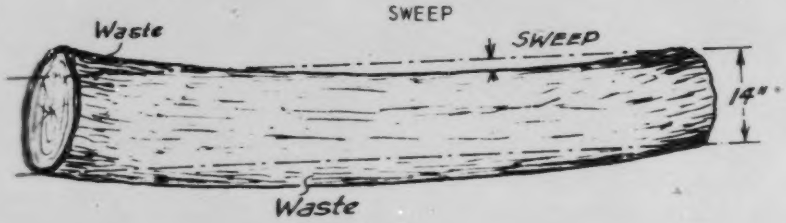
CENTER ROT OR HOLE



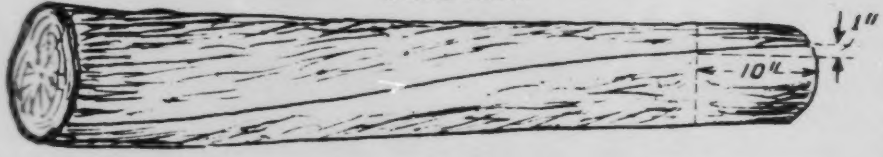
SEAMS



SWEEP

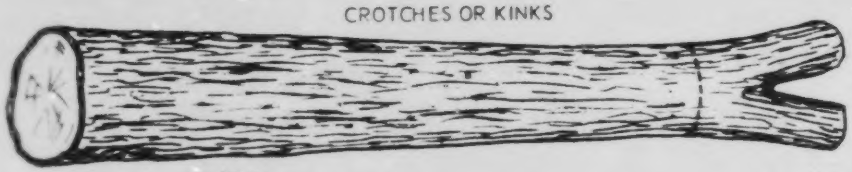


SPIRAL GRAIN



BUTT DEFECTS

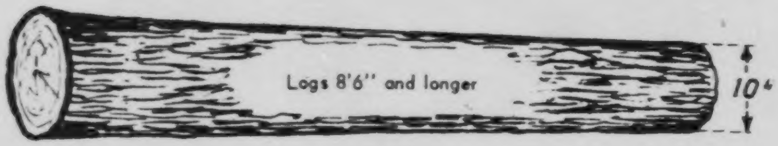
CROTCHES OR KINKS

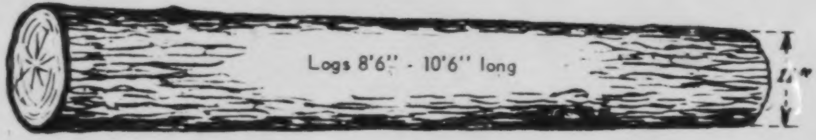


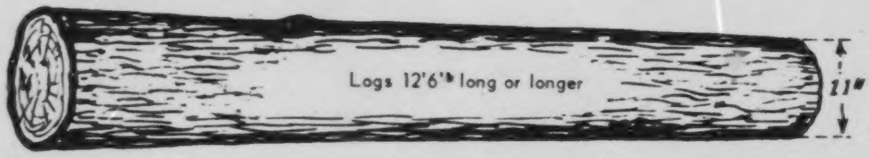
Grade No. 2

Length: Standard lengths are 8'6", 10'6", and 12'6" or longer. Proportion of 8'6" logs is optional with buyer. A trimming allowance of 6" must be added to standard lengths. No logs are admitted with a net scale of less than 50% of gross scale, with a minimum of 30 board feet for each log.

Diameter: All logs must be 10" or larger in average diameter. Logs 8'6" must be surface clear butt logs (except basswood) with a diameter of 10". Logs 8'6" to 10'6" must have a diameter 11" or larger and 10" basswood or larger. They must have 2/3 or each of 3 faces clear in not more than 2 cuttings per face (cuttings 3' or longer). Logs 12'6" or longer must have a diameter 11" or larger and 10" basswood or larger with 2/3 of each of 3 faces clear in not more than 3 cuttings per face (cuttings 3' or longer). A face is a portion of log extending 1/4 of the circumference of the entire log length.







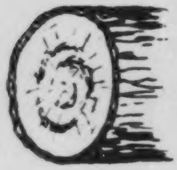
End Defects

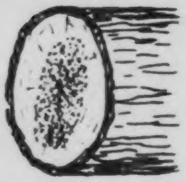
Defects: End defects in Grade No. 2 logs may consist of blackheart, mineral stain, heart rot and shake. Defects on small end must amount to less than 1/2 of average diameter for log to be admitted to Grade No. 2.

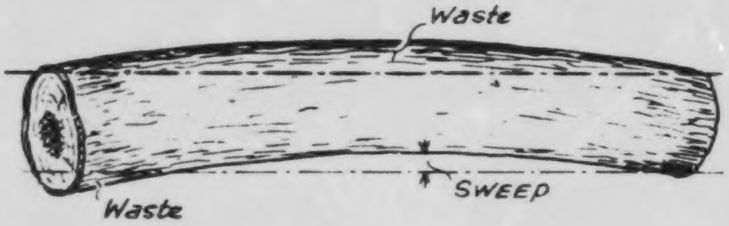
If defect on small end of log 16" or larger in diameter amounts to less than 60% of average diameter of small end, log is admitted to Grade No. 2.

Any defect in butt logs occurring outside diameter of small end is not a grading defect. These include shallow catfaces, folds, fluted butt bark.

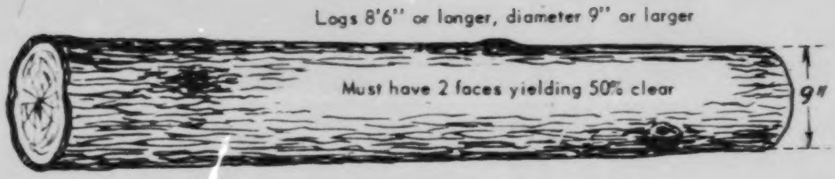
Sweep accompanied by end defects more than 1/4 of diameter at small end, causing a gross scale deduction of 20% or more, is not admitted to Grade No. 2.


Logs 10" - 15" diameter


Logs 16" and over in diameter



Grade No. 3


Logs 8'6" or longer, diameter 9" or larger
Must have 2 faces yielding 50% clear
9"

Diameter: All logs which do not qualify for Grade No. 2 must be 9" or larger in diameter to qualify for Grade No. 3. Logs under 14" are allowed with a net scale of less than 50% of gross scale, with a minimum of 30 board feet required in each log. Logs over 14" average diameter are permitted with a net scale of 33-1/3% gross scale.

Length: Logs which do not qualify for Grade No. 2 must be 8'6" or longer to qualify for Grade No. 3. The proportion of 8'6" logs allowed is optional with buyer.

Quality: Must have 2 faces yielding 50% clear.

Tie Cuts

Length: Lengths are 8' or 8'6" as specified. A 2" trimming allowance is required on all cuts.

Diameter: Minimum average diameter is 9" at the small end.

Quality: Tie cuts or bolts must be cut from sound, green timber, free from decay, split, shake, holes, large or numerous knots or other defects impairing strength or durability of railroad ties. If otherwise suitable, dead cedar and tamarack are acceptable.

Softwoods

White Pine

Veneer Grade: Logs must be 16" or larger in diameter and 10' or longer in length. They must be at least 75% clear on each of 3 faces. All knots outside clear cutting must be sound and not over 2-1/2" in diameter.

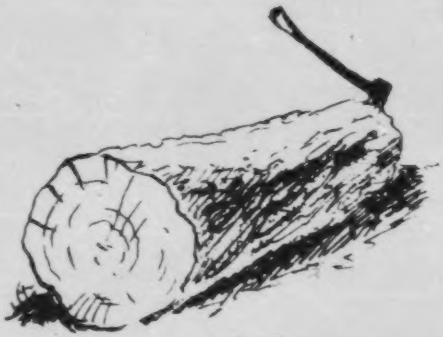
Grade No. 1. Logs must be 12" or larger and 10' or longer; at least 50% clear on each side of three faces or 75% clear on two faces. Logs must have a net scale after defect deduction of at least 50% gross log volume.

Grade No. 2: Logs must be 12" or over in diameter and 8' or longer in length with a net scale after reduction of at least 50% gross log volume.

Other Softwoods

Norway and jack pine, spruce, white cedar, tamarack, hemlock, balsam fir and aspen logs are included. White pine logs less than 12" in diameter also are included.

Logs must be 9" or over in diameter and 8' or longer in length and have a net scale after deduction for defects of at least 50% gross log volume. Minimum net log scale admitted is 20 board feet.



Ted Peterson
Extension Forester

Revised March, 1965

Published and distributed under Act of Congress, May 8, 1914, by the Agricultural Extension Service, College of Agriculture of the University of Wisconsin, H. L. Ahlgren, associate director, the United States Department of Agriculture co-operating.

CHAPTER SIX

GROWING TREES FOR THE PLANTED FOREST

The Planted Hardwood Forest

Hardwood trees grown on the farm add to the farm value and beauty. They supply material for farm use such as lumber, posts, fuelwood, and they help hold soil and moisture. They can be successfully grown on soils too poor or on slopes too steep for agricultural uses.

It is necessary to know certain points in the selection, planting and caring for hardwood trees planted on the farm. Some species, such as cottonwood and willow, can be propagated by cuttings made from a tree of the same species. Others, require the planting of seeds, such as ash, basswood, maple and elm. Planting of nuts is recommended to produce walnut and butternut.

Selection

The best hardwood trees for planting on the farm are usually those that grow naturally on similar soil in the area or are growing successfully on neighboring farms. Failure of hardwood plantings is due mainly to selection of trees unsuited to the soil or climate of the planting site. In deciding what species to plant, keep in mind the following points:

1. The object of growing the trees.
2. Climate of the area.
3. Soil of the area.

Uses of Hardwood Trees in Wisconsin

Species	Lumber	Veneer	Poles Posts	Wind-breaks
Ash	x			
Basswood	x	x		
Cottonwood	x			x
Sugar	x	x		
Maple	x	x		
Elm	x		x	
Red Oak	x	x	x	
Red Oak	x	x	x	
White Oak	x	x	x	
Black Walnut	x	x		
Butternut	x	x		
Black Locust			x	
Willows				x

Propagation By Cuttings

This method is best adapted to willow and cottonwood. Both are relatively fast growing species. Selection of the parent tree is important as it must be of good growth vigor. Cuttings should be made in late fall or early spring. If cut in fall, store the cuttings in moist sand over the winter. If cuttings are made in spring, store them in moist sand in a warm area until ready to plant. Selection of male specimens of cottonwood is suggested to avoid the silkyhaired seeds that fall from the female tree each spring.

Shoot cuttings should be from 12-14 inches long and from wood not over two years of age. Care should be taken to avoid tips of branches and twigs from the current year's growth as they are not considered mature enough.

Use a sharp knife or shearing scissors in making a sharp cut so that the bark is not bruised. Push the cutting into the soil, top it up with one good bud exposed and level with the ground surface. Press the soil firmly around it. Do not force the cuttings into the soil as this injures the cambium at the lower end of the cutting and will interfere with later growth.

Planting of the foot-long cuttings should be started in late April in the southern portion of the state. The farther north, the later the planting date. For all locations in Wisconsin, try to plant before the end of May or before the native willows have burst their buds.

The planting site for willow and cottonwood should be moist, well drained and free from excessive sod. Spacing, recommended for cottonwood, is 10 feet by 10 feet. A two-row cottonwood windbreak spacing should be four feet by 10 feet. For willow, a two-row windbreak spacing of three feet by eight feet is suggested. Willow is of great value in obtaining a network of fast growing roots for erosion control. Planting along streams to hold banks in place or along irrigation ditches is recommended.

Propagation By Seeds and Nuts

In Wisconsin, this method is best suited to ash, basswood, maple, elm and locust. Seeds of these species ripen at various times of the year.

All seeds collected may require special treatment to separate the seed from the fleshy covering pod or hull. Treating with water, applying pressure or allowing to rot naturally will prepare the seeds for a later planting.

If storage of the seeds should be necessary, as in the case of many of the later maturing hardwoods, be sure the seeds do not dry out, as this reduces the power of the seeds to germinate. Cold, moist storage of some type is best suited for most hardwoods.

Seeds Needing Stratification

Walnuts and butternuts need special preparation prior to planting if you intend to plant nuts. Collect the nuts from large, thrifty, well-formed trees. Store the hulled nuts in a cool, moist place until spring. It is essential the nuts are stored in a well-drained box and set where they will be subject to the variations of winter temperatures. See suggested Stratifying Bin, Figure 24.

The stratifying bin, is filled with one or two inch layers of sand or sawdust on the bottom with a layer of walnuts placed on the sand and covered with a new layer of sand. This alternate sand-walnut-sand operation is repeated until the box is filled. Wet the bin and its contents thoroughly and then, during the winter, wet when necessary in order to keep the sand moist. If left in a barn or someplace where rodents can get at the nuts, be sure to screen the top of the box.

Table 9
SEEDING CHARACTERISTICS OF IMPORTANT TREES

Species	Time of Flowering	Time of Ripening	Time of Seed Dispersal	Normal Frequency of Good Seed Yr.	Nursery Sowing Time (Untreated Seed)
Balsam Fir	May	Aug. to Sept.	Sept. to Nov.	2 - 4 yrs.	Fall
Boxelder	Apr. - May	Aug. to Oct.	Sept. to spring	Annually	Fall
Soft Maple	Apr.	May - June	May - June	Annually	Late spring
Hard Maple	Apr. - May	Sept. - Oct.	Oct. to Dec.	3 - 7 yrs.	Fall
Yellow Birch	Apr. - May	Sept. - Oct.	Nov. to Feb.	1 - 2 yrs.	Fall
Paper Birch	Apr. to June	Aug. - Sept.	Sept. to Apr.	Annually	Fall
Bitternut Hickory	Apr. - May	Sept. - Oct.	Sept. to Dec.	3 - 5 yrs.	Fall
Shagbark Hickory	Apr. to June	Sept. - Oct.	Sept. to Dec.	1 - 3 yrs.	Fall
Hackberry	Apr. - May	Sept. - Oct.	Fall to winter	Annually	Fall
White Ash	Apr. - May	Aug. to Oct.	Sept. to winter	3 - 5 yrs.	Sept. - Oct.
Black Ash	May	Aug. - Sept.	Oct. to spring	2 - 3 yrs.	Spring *
Green Ash	May	Sept. - Oct.	Oct. to May	1 - 2 yrs.	Sept. - Oct.
Honey Locust	May - June	Sept. - Oct.	Sept. to spring	1 - 2 yrs.	Spring *
Butternut	Apr. - May	Sept. - Oct.	Sept. - Oct.	2 - 3 yrs.	Fall
Black Walnut	May - June	Sept. - Oct.	Fall	Irregular	Fall
Eastern Red Cedar	Apr. - May	Sept. to Nov.	Feb. - Mar.	2 - 3 yrs.	Aug. 2nd yr.
Tamarack	May	Aug. - Sept.	Sept.	3 - 6 yrs.	Fall
White Spruce	May	Aug. - Sept.	Aug. to Nov.	2 - 6 yrs.	Fall
Black Spruce	May - June	Sept.	Oct. (2 - 3 yrs.)	4 - 5 yrs.	Fall
Jack Pine	May	Sept. 2nd yr.	Fall (several yrs.)	3 - 4 yrs.	Fall
Norway Pine	May - June	Sept. 2nd yr.	Fall to summer	3 - 7 yrs.	Fall
White Pine	May - June	Sept. 2nd yr.	Sept. - Oct.	3 - 5 yrs.	Fall
Cottonwood	Apr. - May	May - June	After ripening	Annually	On collection
Aspen	Apr. - May	May - June	After ripening	4 - 5 yrs.	On collection
Black Cherry	Apr. to June	July to Oct.	July to Oct.	Annually	Fall *
White Oak	Apr. - May	Sept. - Oct.	Sept. - Oct.	4 - 10 yrs.	Fall
Red Oak	Apr. - May	Sept. 2nd yr.	Sept. - Oct.	2 - 3 yrs.	Fall
Black Willow	Apr. - May	May - June	May - June	Annually	On collection
Northern White Cedar	Apr. - May	Aug. to Oct.	Aug. to Oct.	1 - 5 yrs.	Fall
Basswood	June - July	Sept. - Oct.	Fall to spring	Annually	Fall *
American Elm	Apr.	May - June	May - June	Annually	On collection
Slippery Elm	Apr.	May - June	May - June	2 - 4 yrs.	On collection
Rock Elm	May	June - July	June - July	3 - 4 yrs.	On collection

* Seed Pretreatment recommended.

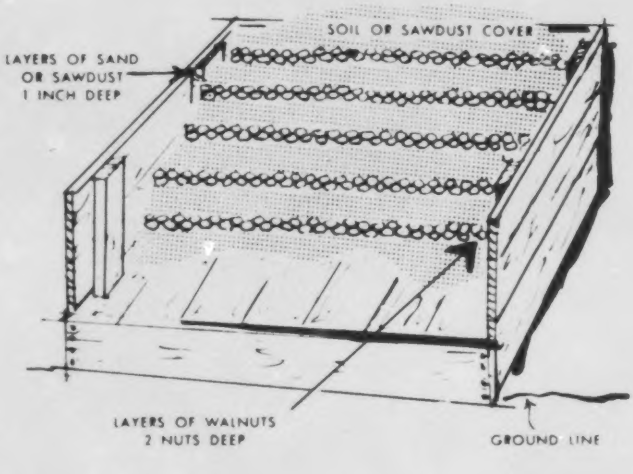
When the nuts are removed from the Stratifying Bin in spring, care should be taken to prevent damage to any of the roots that may have started to grow. A simple test when nuts are removed from the bin will tell you which nuts are hollow or nonvaluable. Put the nuts in water. The unsound nuts will float and should be eliminated.

Planting

There are both advantages and disadvantages to planting seed as opposed to planting seedlings. The prime factor in favor of direct seeding of nuts is the elimination of damage to the root system that occurs during transplanting. Secondly, a field-grown seedling, established from a nut, does not suffer the shock from a change in soil that is unavoidable in transplanting. A third consideration is cost. A savings in labor and planting stock expense can be realized if walnut seed can be successfully utilized.

However, rodents pilferage more than offsets the advantages of planting seed as opposed to planting

Figure 24
WALNUT STRATIFYING BIN


SOIL OR SAWDUST COVER
LAYERS OF SAND OR SAWDUST 1 INCH DEEP
LAYERS OF WALNUTS 2 NUTS DEEP
GROUND LINE

seedlings. Many chemicals and devices have been experimented with in hope that they would reduce rodent damage to planted nuts. None of the methods applied have proven to be successful or economically practical.

One area that does prove to be conducive to nut planting is the open farmland in the counties within the walnut range of Wisconsin. If there are squirrels, chipmunks, etc., near your planting site, you should anticipate damage and losses in your planting.

Recommended Planting Procedures

1. Planting should be started in spring after the danger of late frost is past.

2. Don't plant nuts by a method such as jabbing a stick in the ground and stamping the nut into a hole. While this is a labor-saving system, it doesn't work. Instead, dig a hole at least eight inches wide by six inches deep. After digging, return all but three inches of loose soil to the hole. At this point, place the nut in the hole and finish filling.

3. Leave the soil slightly mounded over the seed to compensate for settling.

4. If time is available, it will help seedling growth to plant the nuts on their sides.

Black walnuts are not recommended for planting in pure stands. It is found that the site quality cannot be maintained because the density of the canopy is not sufficient to sustain an adequate layer of forest litter and humus. Plantings over one-half acre should not be attempted. Best results are obtained when walnut is mixed with other hardwoods. An ideal mixture would consist of maple, ash, oak and walnut. Additional information can be obtained from your local forester.

Planting Hardwood Seedlings

Many nurseries in Wisconsin are now growing and selling one- and two-year-old hardwood seedlings. Species, such as hard maple, white ash and red maple, are usually available. These seedlings are most successful if used to "sweeten" an existing hardwood stand. Planting techniques are similar to those applied to conifers. A random spacing throughout a woods or a mixture of species in openings is recommended. On heavier, well-grained soils, hardwoods should be considered. This is especially true in the southern portion of the state.

Spacing of hardwoods should be close if the trees have spreading crowns, such as oaks and maples. It is often necessary to think of many factors that can influence the spacing used. Some factors are:

1. Size of planting stock and possible survival after planting.
2. Planting site.
3. Species being planted.
4. Absence or presence of competing vegetation.
5. Planting objective.
6. Future accessibility.

In most of Wisconsin, a spacing of not greater than 5 feet by 5 feet is suggested for hardwood plantings used to "sweeten" existing stands.

The Planted Coniferous Forest

Cone collecting, whether for sale or for use in your own school nursery, can be interesting. Easiest to collect are the cones of white pine, norway pine, jack pine, white and black spruce. Other coniferous seeds may be desired eventually but are not recommended for the beginning nursery.

In undertaking any project in connection with cone collecting, it is best to visit or invite local forestry men for advice on when to collect, what to collect, and where to go collecting.

Collecting, Storing And Planting Seeds Of Cone-Bearing Trees

Raising coniferous trees from seed is an exacting job. It requires special knowledge and equipment and is not recommended for the amateur. Furthermore, it is usually more economical to buy seedlings and transplants from state and commercial nurseries than to grow your own trees from seed. However, most nurseries depend on private sources for seed, thereby providing a source of income for tree seed collectors. Also, some landowners may wish to raise trees from a specific source, or just for the experience of growing their own planting stock.

When to Collect

Most coniferous trees have cones whose seeds ripen in the fall, generally in September and lasting into October. Immature cones are generally green, and as they ripen, gradually turn brown. Ripeness is customarily determined by cutting open the cone and determining whether the seed is firm and hard. The seeds are in pairs beneath the cones scales. Ripe cones will usually float in water or kerosene. Squirrels usually cut cones when they are ripe, and sometimes many cones can be gathered from caches made by these animals.

Where to Collect

Cones should be collected from trees which are healthy and vigorous. Diseased or undersized cones should be avoided. Keep your cones separate if collecting more than one kind. Norway and jack pine cones can sometimes be picked or cut from the lower limbs of standing trees. Cones should not be picked from the ground unless you are sure they are cut by a squirrel and are good. The easiest way to collect cones is from the tops of trees cut in a logging operation. Be sure to get permission when you do this.

Points to Remember in Collecting Cones For Seed

Seeds are found inside the cone on the upper surfaces of the cone scales. Open cones have dropped their seed, so collect closed cones only, preferably by picking them from trees.

1. Collect ripe cones. Cones will ripen at different times, depending on the species and on the part of the state. Generally, balsam fir, spruces and tamarack cones ripen from late August to early September; white cedar from August to October; jack pine during September; red

and white pine and hemlock during September and October, and Scotch pine from October to March.

Each variety of ripe cone looks different. However, usually all ripe cones are brown or purplish. The best test is to examine the individual seeds. If a seed is full, plump and white but not milky the cones are ready to pick.

2. Squirrels often cut down ripe cones. These can be picked up from the ground. However, be sure to check ripeness.

3. A stepladder will help you reach cones on the tops of smaller trees.

4. If seed-bearing trees are harvested for lumber, pulpwood or other purposes during the period when cones are ripe, they can be collected from the tops.

5. When picking cones by hand, bend the needles back and twist off the cone.

6. To pick cones with a cone hook, fasten a stout wire (in the shape of a hook) on the end of a pole. Cones, which would otherwise be out of reach, can be pulled from the trees with this hook.

Before seeds can be extracted from the cones, it is necessary to dry the cones for a time. During this period, the cones should be spread out in a warm place free from moisture, and protected from rodents and birds. As they dry, the cone scales will open. Some seed will fall out of the cones. When the cones are open, the seed can be extracted by raking the cones back and forth, shaking in a bag, or tumbling in a drum.

Cleaning and Storing Seed

Extracted seed is usually de-winged and cleaned before being stored or used. Wings can be removed from the seeds by rubbing them over a screen or kneading them in a sack. Pouring the seeds from one container to another when the wind is blowing or with a fan blowing will remove the wings and other debris.

Cleaned seed should be put in sealed fruit jars and stored in a cool dry place until you are ready to use them.

A germination test of the seed may be run by placing 100 to 200 weeds in a shallow tray of sand and keeping them well-watered in a warm sunny place. About half the seed should germinate in four weeks in the case of Norway pine and jack pine, and six to seven weeks for black spruce.

Selling Ripe Cones

Ripe cones are usually purchased by the standard bushel measure (quantity not weight). After you've collected the cones, empty them into a gunny sack or bushel basket and deliver them promptly. The Department of Natural Resources usually buys cones in the fall. Private cone dealers also purchase cones. For the current state price lists, contact the Bureau of Forestry, Wisconsin Department of Natural Resources Madison.

Raising Your Own Trees From Seed

Raising planting stock from seed is not an easy project. Constant care is necessary to provide adequate moisture, keep weed competition down, and protect the seedlings from insects and diseases.

Every year, millions of trees are produced by state and commercial forest nurseries for forest plantings, shelterbelts and windbreaks. Trees for reforestation can be purchased from the state forest nurseries at near the cost of production. The state puts some restriction on the uses of these trees. For example, a certain number of trees must be left, per acre, to grow into sawtimber. Also, trees cannot be harvested with roots attached. Commercial nurseries produce a wide variety of species and sizes. No restrictions are placed on trees purchased from commercial nurseries. Purchasing planting stock is usually cheaper than raising your own trees from seed. However, if you decide to raise your own trees, the following information may be helpful for this project.

Construction of a Small Tree Nursery

Location of Seedbed

Although a seedbed requires little space, (4′ x 12′) there are important requirements that must be considered which will effect the choice of location. Some of these requirements are:

1. An adequate source of water.
2. A well-drained site, exposed to sun, and protected from drying winds, but having some ventilation.
3. An acid and preferably sandy soil.
4. Protected from animals or livestock.

Preparation of the Seedbed

Dig and spade the soil thoroughly about one foot, breaking all lumps. All debris and stones should be removed.

A loamy sand or sandy loam is the best kind of soil for this purpose.

Next, make a frame of 1″ x 4″ or 1″ x 6″ so that a seedbed 4″ wide and 12′ long can be formed. Set this frame on edge about 1″ deep in the ground. From the surrounding area, add enough soil to raise the surface of the bed about 1″. If the soil is loam, it should be rounded upwards towards the center of the bed. If it is sand, it may be flat. Soil should be firmed, not packed, with a board.

Planting the Seeds

Conifers seed may be seeded late in October or in April and May. White pine and white spruce will give the best results from fall seeding.

If the seed is treated with a commercial fungicide, the survival will be increased. Fungicides are available from most drug or feed stores and are generally in powder form. Care is needed in their use.

Before planting, the surface of the seedbed should be loosened by raking. Sow the seed broadcast or in rows 4-6 inches apart, to a depth of four times the size of the seed. Seeds sown in rows should be pressed into the soil and lightly covered. After seeding, the seedbed should be covered with a thin layer of clean straw, sawdust, or burlap.

Plan to raise about 50 seedlings per square foot of seed bed. On the average, to raise 50 seedlings per square foot, the following quantities (in ounces) of seed will be needed for every 100 square feet of bed:

Tree	Seed
Balsam fir	10 ounces
Hemlock	4 ounces
Jack pine	3 ounces
Red pine	3 ounces
Scotch pine	2 ounces
White pine	7 ounces
Norway spruce	3 ounces
White spruce	3 ounces
Tamarack	5 ounces
White cedar	3 ounces

Care of Seedlings

After seeding, the bed should be kept moist, not soaked. Remove the straw or covering when two-thirds of the seedlings have germinated. Keep the weeds pulled when small. It may be advisable to partially shade the seedbed when the seedlings are young and tender. A lathfence, supported over the bed, will serve this purpose. The shade should be removed on cloudy, humid days.

After the first six weeks, the rows can be thinned to allow better spacing. Leave at least 50 seedlings per square foot. Most seedlings are left in the seedbed for at least two years before being transferred to transplant beds. Planting stock age is usually referred to in a double number such as 2-0. The first number refers to the number of years in the seedbed, the second number to the number of years, if any, in a transplant bed.

Transplant Beds

After two growing seasons in the seedbed, seedlings may be transplanted to beds similar to the seedbeds except the trees are spaced wider. This should be done in April or May or even in early September.

At the time of transplanting, the seedling should be root pruned. The long side roots, as well as the tap root, should be clean-cut so a small compact system is left to develop numerous fine roots that can be handled without loss at planting time.

Seedlings can be planted individually. By using a transplant board this process can be speeded up. A transplant board is made so that several trees can be planted in a trench at one time. Trees are threaded into notches 2" apart and held between boards compressed by springs. Tension should be only enough to prevent slipping, with rubber buffers to prevent damage to stock.

Care must be taken to keep the seedlings' roots moist at all times during transplanting. Trenches should be made just before planting to prevent drying of the soil.

In transplanting, the rows may be spaced 12" apart and the trees spaced 2" apart in rows. The rows are trenched with the aid of a wide, heavy, metal blade. The depth of the trench should allow enough room for the seedling roots to hang straight down when transplanted.

After transplanting, the beds should be kept free from weeds and given adequate moisture. At the end of one or two years, the stock is ready for planting in the forest.

Tree Planting Machine in Operation

Planting the Forest

General Considerations

Tree planting, as viewed by professional foresters, is a "last resort" forestry practice that should only be used when all other forestry techniques fail to produce a satisfactory stand of trees in a reasonable length of time. Forest lands, properly managed, can frequently reseed themselves naturally at a minimum cost to the landowner. There are hundreds of thousands of acres of forest land in Wisconsin that will reseed themselves satisfactorily if proper timber harvest methods are employed, if livestock are removed from the woodlands, and if fire, insects, and disease are controlled.

If the area in question will not readily reseed itself naturally, or if the area is open land devoid of forest cover, artificial tree planting becomes practical. Even though tree planting is relatively expensive, it is justified in these cases because it may take decades for the forest to establish itself naturally.

Objectives

Trees are planted for many reasons, but in Wisconsin, they are planted primarily for the future production of forest crops, such as Christmas trees, fence posts, pulpwood, piling, sawlogs, and veneer logs. A properly executed forest plantation (planting) is a sound investment in time and dollars when the owner considers the cash return he will receive when he sells his future forest crop.

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Table 10
GUIDE FOR PLANTING GAME FOOD SHRUBS

Species	Planting Site					Soil Acidity	Avg. Ht.	Fruit		Valuable For	Wildlife Using								
	Dry	Well Drained	Moist	Sun	Shade			Ripens	Persists		Ruffed Grouse	Prairie Chicken	Sharptail	Bobwhite	Pheasant	Squirrel	Rabbit	Songbird	Deer
Mountain Ash	x	x	x	x		Slightly acid	25'	Aug.	March	Winter food	x		x					x	x
White Ash		x	x	x		Neutral	75'	Oct.	Nov.	Winter food							x	x	x
Bittersweet	x	x		x	x	Neutral	vine	Sept.	All year	Food and cover	x		x	x				x	
Blackhaw	x	x	x	x	x	Neutral	10'	Aug.	March	Winter food			x	x	x			x	x
Buffaloberry	x	x	x	x	x	Neutral	12'	July	Sept.	Food cover	x	x	x		x			x	
Caragana	x	x		x		Neutral	3-4'	Sept.	Nov.	Food cover		x		x	x			x	x
Wild Crab		x		x		Acid to alkaline	17'	Sept.	Nov.	Food cover	x		x		x		x	x	x
Highbush Cranberry		x	x	x	x	Slightly acid	8'	Sept.	April	Winter food	x		x		x			x	
Coralberry	x	x	x	x	x	Neutral	4'	Sept.	All year	Winter food	x		x	x	x	x	x	x	
Dogwood		x	x	x	x	Slightly acid	8'	Aug.	Nov.	Food	x		x	x	x			x	x
Honeysuckle	x	x	x	x	x	Neutral	9'	July	Oct.	Food	x				x			x	
Hackberry	x	x	x	x	x	Neutral	40'	Sept.	Nov.	Winter food		x	x	x	x			x	
Lilac	x	x	x	x		Neutral	12'	Aug.	Oct.	Food cover						x		x	x
Ninebark		x	x	x	x	Neutral	8'	Aug.	Oct.	Food cover	x							x	
Plum	x	x	x	x	x	Neutral	15'	Aug.	Oct.	Food cover		x	x		x				
Multiflora Rose	x	x		x		Neutral	7'	July	May	Food cover	x	x	x		x	x	x	x	
Thornapple	x	x	x	x		Slightly acid	12'	Aug.	Dec.	Food cover	x		x	x	x		x	x	
Wayfaring Tree		x	x	x	x	Neutral	9'	Sept.	March	Winter food	x	x		x	x			x	

All of the above plants are winter hardy in all of Wisconsin with the exception of multiflora rose. It is recommended that multif'ora rose be planted only in the southern one-third of the state. This plant, when planted in double or triple rows with the plants one foot apart, provides a completely stockproof fence in four to five years. It does not spread from the roots or reproduce itself readily from seed. If possible, it is recommended that they be cultivated and fertilized during the first year and mulched the first winter.

Table 11
GUIDE FOR PLANTING FOREST TREES

SPECIES	GENERAL SOILS AND EXPOSURE												MINIMUM REQUIREMENTS			
	Dry Uplands				Well-Drained Uplands						Wet Lowland		Ability to grow in Shade	Soil test for pH	Moisture	General Use
	Dunes or Shifting Sands	Sand			Sandy Loam			Clay-Clay Loam			Sand to Clay	Muck or Peat				
		Level	Exposure		Level	Exposure		Level	Exposure							
			N&E	S&W		N&E	S&W		N&E	S&W						
Cedar, White					x	x		x	x		x	x	Fair	4.0-8.0	Moist upland	Posts
Fir, Balsam[1]					x	x		x	x		x	x	Good	4.5-6.0	Moist upland	Pulp
Pine, Jack	x	x	x	x	x	x	x						Poor	5.0-6.8	Dry	Pulp—Lbr.
Pine, Red		x	x	x	x	x	x						Poor	5.0-6.5	Dry	Pulp—Lbr.
Pine, White[4]			x		x	x	x	x	x				Fair	4.8-7.3	Moist	Lbr.
Spruce, Black[1]					x	x		x	x		x	x	Good	4.0-6.5	Moist	Pulp
Spruce, Norway[2]					x	x		x	x	x			Fair	4.8-6.5	Moist upland	Pulp
Spruce, White					x	x		x	x				Fair	4.8-6.5	Moist upland	Pulp
Tamarack					x	x		x	x		x	x	Poor	4.5-6.5	Moist	Posts

[1] Plant only in northern one-half of Wisconsin.

[2] Plant only in southern one-half of Wisconsin.

[4] Before planting white pine consult the forester in regard to insects and diseases affecting it.

SPECIES	GENERAL SOILS AND EXPOSURE												MINIMUM REQUIREMENTS			
	Dry Uplands				Well-Drained Uplands						Wet Lowland		Ability to grow in Shade	Soil test for pH	Moisture	General Use
	Dunes or Shifting Sands	Sand			Sandy Loam			Clay-Clay Loam			Sand to Clay	Muck or Peat				
		Level	Exposure		Level	Exposure		Level	Exposure							
			N&E	S&W		N&E	S&W		N&E	S&W						
Ash, White					x	x		x	x				Poor	6.9-8.0	Moist	Lbr.
Basswood					x	x		x	x				Good	5.5-7.5	Moist upland	Veneer—Lbr.
Cottonwood					x	x		x	x	x	x		Poor	5.5-8.0	Moist to wet	Lbr.
Elm, American					x	x		x	x		x	x	Fair	5.0-8.0	Wet	Lbr.
Locust, Black[3]					x	x		x	x	x			Poor	6.0-8.0	Moist upland	Posts
Maple, Soft		x	x		x	x		x	x		x	x	Fair	5.0-8.0	Moist	Lbr.
Maple, Sugar					x	x		x	x				Good	5.5-7.5	Moist upland	Veneer—Lbr.
Walnut, Black[3]					x	x		x	x				Poor	6.5-8.0	Moist upland	Veneer
Willow					x	x		x	x		x	x	Poor	6.0-8.0	Moist	Erosion control

[3] Plant only in southern one-third of Wisconsin

Another important reason for planting trees in Wisconsin is to protect the soil from wind erosion and to protect buildings from unfavorable winds. The establishment of shelterbelts and windbreaks is discussed in another section of this manual.

Trees are frequently planted to improve wildlife habitat, especially in agricultural areas of the state. The edge of plantations in a farming landscape, provides protective cover from predators for many species of game animals and also provides protection from severe weather conditions.

Trees also tend to improve the quality of water in streams, stabilize stream flow especially in agricultural areas, reduce the danger of flooding, improve habitat for many popular varieties for game fish, and reduce the erosion of agricultural soil.

What Kind of Trees to Plant?

Probably the best way to decide what species of trees to plant is to consider only those species that will do best on the area to be planted. Table 11 is a general guide for choosing the proper species. After the adapted species have been determined from the table, the landowner should choose the one or more species that will best suit his needs. For example, some trees make better Christmas trees while others produce the best lumber.

While the planting guide may be sufficiently accurate for small plantings that involve little time, land, or money, a landowner should always consult a professional forester before entering large scale tree planting operations.

Tree planting is a long-term investment. Poor decisions are compounded as the years go by. From an investment standpoint, it would be better for the landowner to lose a plantation of the wrong species the first year. Many such plantations tend to struggle along, losing money for the owner each year.

Good initial survival does not mean that the species have been planted on the proper site. The effects of planting trees on the wrong site usually do not show up for at least five years or even longer. Poor height growth, poor color, continuing losses to drought, and insects and disease, gradually take their toll over the years. The plantation then becomes a liability rather than an asset.

When selecting the species to plant, it is a good rule to select only native species. The use of exotic species usually ends in plantation failure, especially if the final crop is a forest product larger than Christmas trees.

Guide for Planting Forest Trees

In addition to the species of trees, the kind of planting stock is also important. Most planting is done with nursery-grown trees. Occasionally, naturally seeded trees, or "wildings", are dug from the woods and set out. Cottonwood from river bottoms have been successfully transplanted to higher grounds. With few exceptions, wild seedlings have poorly developed root systems as compared to nursery-raised trees and are not recommended for large scale plantings.

Tree Planting-Ordering Trees

Trees for planting in Wisconsin are available from several sources. These include growers such as the Department of Natural Resources and private nurseries.

It is a general practice for these growers to make their nursery inventory and establish their prices in the early fall. Order blanks for trees are usually available by mid-October or delivered in spring.

State Nurseries:

Presently, state nurseries, located at Hayward, Wisconsin Rapids and Boscobel, provide trees to private landowners and governmental agencies for forestry purposes. Both coniferous and deciduous species are grown and trees are sold either as seedlings or transplants. Trees are lifted in the southern nursery around April 15. The northern nurseries' shipping schedule is usually May 1 to May 30.

The procedure for purchasing trees from state nurseries is:

1. Obtain a tree order blank from your local forestry office, county agent or Soil Conservation Service office.
2. Fill in blank completely, including plant and sign location. Payment must accompany order.
3. Shrub order blanks for wildlife planting are available at the same time. Department of Natural Resources game managers have the blanks.
4. Return the completed order with payment to the forester in the county where the trees will be planted. Trees and shrubs obtained from state nurseries cannot be used for ornamental purposes, for resale as living trees or for sale as balled stock. These trees are produced for forestry purposes only. The stock is selected for rapid growth and does not lend itself to ornamental use.

Private Nurseries:

A listing of private nurseries and species is available at the forestry offices throughout the state. Where intended use of the planting stock is contrary to state-imposed restrictions or where choice of species is not available from a state nursery, it is best to obtain stock from a private nursery within the state. The shipping schedule is similar to the dates shown for the state nurseries. Some private nurseries may have a fall shipping schedule. It is suggested you contact the individual nurseries to check on the availability of trees in the fall.

Planting stock, provided by forest-oriented industries or associations, varies in number of trees provided, distribution areas and other factors that require a contact with the providing agency in the fall to learn of the eligibility for available trees.

Free Tree Program:

Trees are made available without charge by the Department of Natural Resources to youth groups such as 4-H, Future Farmer, Vo-Ag classes, Boy Scouts and other similar organizations for officially sponsored projects in forestry or other conservation activities. The Department of Natural Resources must be assured the project will have adequate supervision.

Limitations on trees vary according to the program. 4-H and Vo-Ag students receive allotments according to the number of trees available each year. All programs are coordinated to insure proper distribution of the available trees, and a successful planting experience by the youth participating in this conservation activity.

Spacing

A spacing of six feet by six feet is the standard spacing recommended by Wisconsin foresters. If 10 to 20 percent of the trees do not survive, a satisfactory stand of timber will still result. If there is little mortality, it may be necessary to make a light thinning for fence posts before the stand becomes too dense and the growth rate is reduced.

Various other spacings are recommended for special forest products. A Christmas tree grower may want to grow more trees per acre than a lumber company interested primarily in sawlogs. The following table shows the number of trees that can be planted on an acre at various spacings:

Spacing in Feet	Number of Trees Per Acre
3 x 3	4,840
4 x 4	2,722
5 x 5	1,742
6 x 6	1,210
7 x 7	889
8 x 8	681
10 x 10	435

Direction of Rows

In general, it has not been shown that the compass direction of rows has much effect on the success of a forest plantation. In many cases, it may be more desirable to follow approximate contour lines. When planting with a mechanical planting machine, it has been found that the machine will function best if the planting is carried on in the same direction as the abandoned field. Old dead furrows do not interfere with the scalpers on the planting machine, when planting in the same direction the field was originally worked.

Another consideration when using a planting machine, is to plant the field so that a minimum amount of time will be spent turning around. This usually means that the planting must run lengthwise rather than crosswise on a rectangularly-shaped field. When planting in hilly country, it may be necessary to run the rows up and down the hills, rather than on the contour, because most machines and tractors cannot be adjusted to compensate for side-hill planting. When planting is completed, it is easy to spade in small check dams in the furrows to prevent water erosion in the steeper slopes. After a year or two, vegetation establishes itself in the furrows and water erosion is no longer a hazard.

Accessways and Firebreaks

As a general rule, an accessway should be left around the entire periphery of the plantation for protection, management, and wildlife values. This accessway should be at least 25 feet in width. There will be areas where the accessway around the periphery of a plantation is not feasible or necessary due to topography, irregularity of the plantation, natural breaks, or plantations being intermingled with other types.

Two rows of trees should be omitted (only in the general direction that the plantation is planted and approximately 18 feet if the spacing varies from six feet by six feet) at approximately 300-foot intervals, regardless of the size of the plantation, if the plantation is over 600 feet in width. If the plantation is more than 300 feet wide, but less than 600 feet wide, the accessway should be left through the middle of the plantation. Some landowners may wish to plant the two rows and remove them as a Christmas tree thinning.

Windbreaks

A windbreak is a belt of trees three or more rows wide, set in the vicinity of farm buildings, designed to restrict formation of snowdrifts to unused areas in the winter. It also reduces the velocity of winds in the vicinity of farm buildings, and tempers the severity of low temperatures accompanied by high winds.

Selection of Planting Site and Advance Preparation

Local conditions in the vicinity of farm buildings strongly influence the ultimate decision on location. The basic principles for the most effective results are:

a. The tree belt should be to the north or west of the buildings.
b. The tree belt should not be more than 100 feet away from the structures or exercise areas to be protected and not less than 30 feet in order to avoid the nuisance of snowdrift accumulation.

Advance planting site preparation is influenced by present land uses and the need for fencing to keep out poultry and livestock.

a. If currently in sod, plow under the sod, and thoroughly disc at least six months in advance of planting.
b. If in recent cultivation, or used by livestock for exercise area, disc thoroughly but do not turn under with mold-board plow a week or two before planting.
c. Where an L-shaped windbreak is possible prepare the soil as indicated above and remove any portable or temporary structures which would interfere.

Selection and Arrangement of Pines Within the Windbreak

Limb density near ground, and maximum height of mature trees are primary objectives. Planting a minimum of three rows, and using species noted for ability to retain lower limbs, are fundamental.

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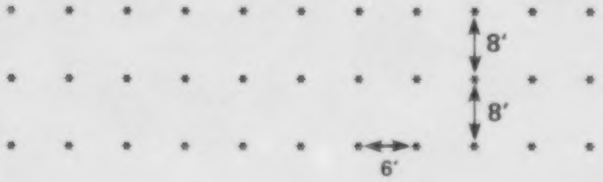
a. For heavy soils-
   (1) In the center or middle row—white pine
   (2) Border rows—white spruce, Norway spruce. (Colorado blue spruce may be chosen for the row facing the farm buildings, or for the row nearest the farm house.) White cedar or arbor vitae also is acceptable.
b. For light soils-
   (1) Center row—Norway pine or white pine
   (2) Border rows—Norway spruce, provided soil is kept deeply mulched with rotted silage, pea vines, bark or chips. Siberian pea shrubs, as an alternative to spruce on light soils, has proven to be effective.

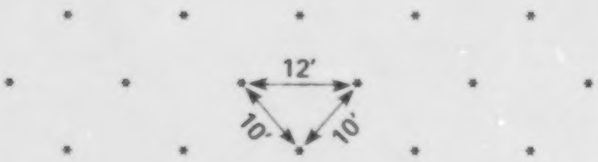
Rows should be eight feet apart; trees should be six feet apart in rows. In planting an L-shaped break, plant nine trees in check rows in the corner at a spacing of eight feet by eight feet as diagramed. Note diagonal spacing after thinning. (See Figure 25.)

Figure 25

Original Spacing



Spacing After Thinning



Cultivation

An effective form of cultivation is to use the area for gardening purposes for two years after planting. Light cultivation or discing in early summer prevents the formation of sod. Late growth annual weeds are not harmful.

Size of Planting Stock

Nothing smaller than four-year transplants.

Restoring an Old Windbreak

In many prairie areas in the state, single or double rows of old spruce trees present a ragged appearance. They can be improved in appearance and service by establishing border rows on the leeward (protected) and windward sides.

a. Clear off all competing shrubs and brush around the old-growth trees.
b. Prepare a planting, as for a new windbreak, to windward and leeward sides of the break.
c. Apply heavy mulch of rotted straw, silage, pea vines or other organic material on the soil above the roots of old trees, add commercial fertilizer.
d. Plant a single row of white cedar on the windward, and another on the leeward side of the belt-tree rows 10 feet from the old trees, the cedar trees to be three feet apart in the rows.
e. Cultivate lightly in early summer for at least two years after planting.

Shelterbelts

A shelterbelt is a belt of trees, three or more rows wide, planted parallel, at right angles to prevailing winds, at intervals of 40 or more rods, for the purpose of preventing the drifting of surface soil, principally in sandy areas; and for trapping snow on the intervening fields.

Choice of Species

Red pine is the most generally accepted tree; white pine may be used on windward (usually the westernmost row; border row of Siberian pea, a low shrub, has proven to be helpful on leeward side of shelterbelt).

Spacing

Rows six to eight feet apart, trees six feet apart in rows.

Planting and Subsequent Care

Since shelterbelts are planted on cropland, machine planting is easiest, except that some small plantings may not justify hiring a machine. Cultivate early in the summer for the first two years. If Scotch pine plantations exist in the neighborhood, provide defense against root collar weevil by drenching the base of each red pine tree with benzine hexachloride every three years. Never remove any living limbs on border rows, as these are essential to prevent excessive movement of surface snow and light snow. Interior pruning of dead limbs is recommended.

Intervals Between Belts

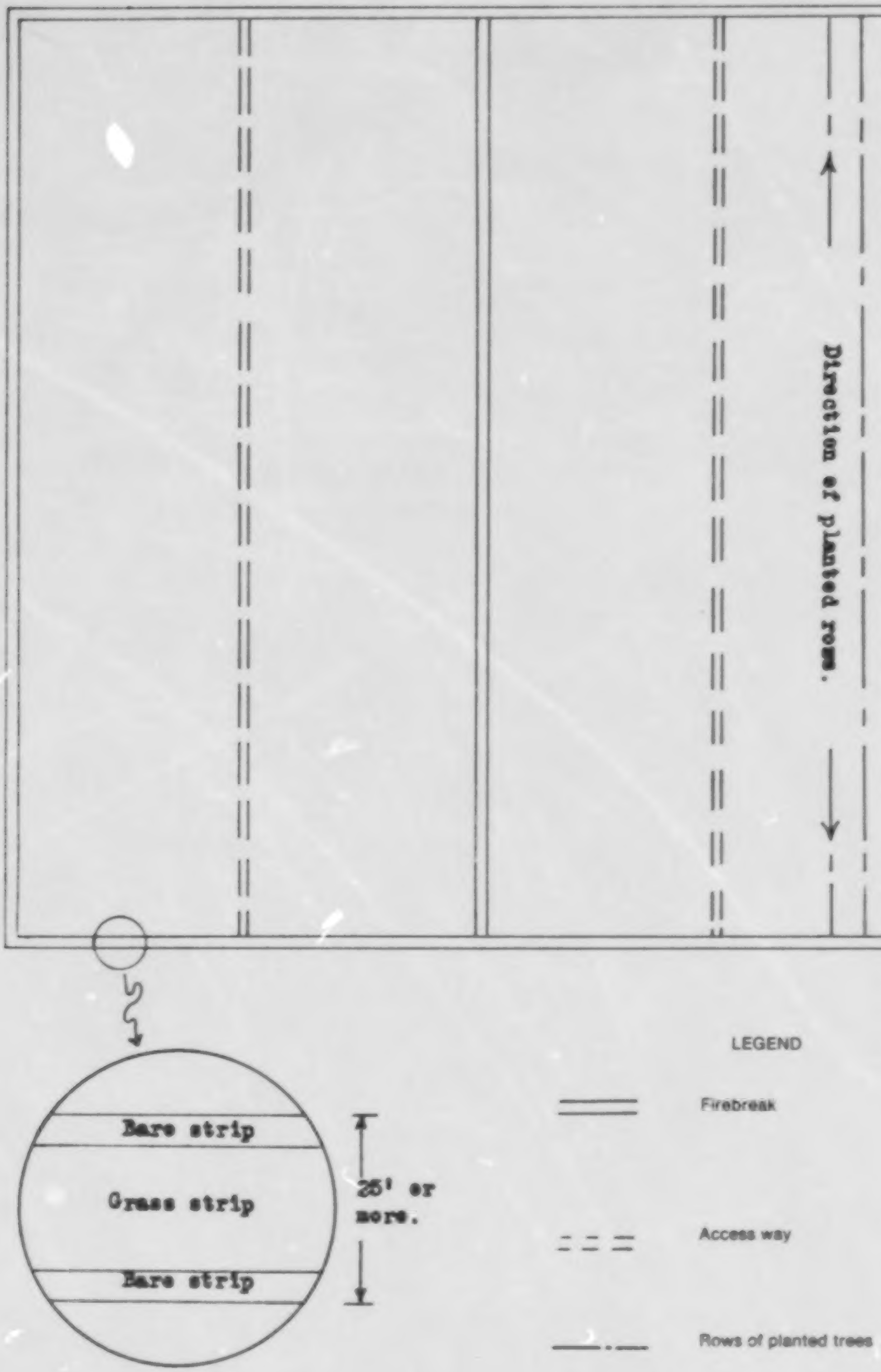
Maximum effective distance between belts: 80 rods. For 25-year-old trees, the most practical spacing for efficient use of machinery, is usually 20 to 30 rods.

Site Preparation

Under most Wisconsin conditions, it is necessary to remove competing vegetation by scalping, furrowing or by killing vegetation with herbicides. Many plantation failures have occurred because this important step was omitted.

Furrows for planting should not be any deeper than the depth required for good planting, in order to facilitate the use of mechanized equipment in harvesting products or protection. On areas exposed to dessicating winds or invasion of weeds, deep furrowing may be imperative for

Figure 26
SYSTEM OF FIREBREAKS AND ACCESS WAYS IN A 40-ACRE PLANTATION


Direction of planted rows.
Bare strip
Grass strip
Bare strip
25' or more.
LEGEND
Firebreak
Access way
Rows of planted trees

survival and satisfactory growth of trees. Such locations should be checked by a forester and his recommendations followed.

A large amount of new data is being collected by foresters pertaining to the use of chemical herbicides for controlling competing vegetation. A professional forester should be contacted before substituting herbicide preparation for conventional scalping or furrowing.

Handling the Nursery Stock

Improper care after the trees arrive has probably resulted in more plantation failures than any other factor. It is most important that the stock be planted as soon as possible. When you are notified that the trees have arrived, pick them up promptly.

If trees are to be planted within four to five days after arrival:

1. Immediately after receiving the trees, stand the bundle on end and pour a bucket of water through the open end. Cut the bundle open, unroll, then reroll loosely and keep moist.
2. Store in a cool damp place. A milk house, basement, or the shade of a building are good storage places.
3. Water at least once a day by thoroughly soaking the material covering the trees.

Handplanting

Regardless of the method of planting, it is most important to keep the tree roots damp at all times. Carry the trees in a bucket with three to four inches of water, or in a box with the roots under wet moss or burlap. Take out only one tree at a time when planting.

Plant the trees about one-half inch deeper than they grew in the nursery. The old soil line can be recognized by the paler-colored bark on the stem and also a slight bump or swelling at this point.

The hole or slit should be deep enough to prevent curling or bunching of the roots. It is important that the soil be firmly packed around the roots after planting. Special care should be taken to close the bottom of the hole as well as the top.

Considerable time can be saved and root injury prevented if a little time is spent separating and sorting the trees before planting. Sorting should be done in a shady place protected from the wind.

Machine Planting

Planting machines are limited to areas that can be worked with farm equipment. Some of the heavier machines pulled with a crawler tractor can plant in heavy brush or rough terrain.

These machines plant at the rate of 800 to 1,000 trees per hour, so it is practical to use them only on large plantings.

Since there are several types of planting machines, it is impractical to give machine-planting procedures here. Be sure the machine used opens an adequate planting slit and that it packs the trees in firmly. Before starting, get instructions on the use of the machine from the local forester or the owner of the machine from the local forester or the owner of the machine. If the planting is to be done on a custom basis, be sure the operators are trained, experienced men. The cost of machine planting varies greatly. Your local forester will be able to give your current costs.

Protecting Seedlings From White Grubs

White grubs have been very deterimental to tree plantings especially white pine. Pesticides have been used to some extent for white grub control, but because of hazards involved, caution has to be taken. Before using any pesticide, check with local foresters.

Use of Fertilizers

Experiments and research indicate commercial fertilization is not economically sound.

Site Selection for Field Planting

Forest Soils

Soil is the surface layer of the land in which the nonliving or mineral world comes into direct contact with the living or organic world. This layer of the earth's crust stores vast quantities of energy, captured by photosynthesizing plants. Soil is always in a state of activity and is constantly changing its composition.

The knowledge man possesses of forest soils is generally considered to be of recent origin. Written records of pioneer studies of forest soils date to the middle of the past century. However, long before soil specialists began their investigations, Indians in America and tribes in Eurasia had a remarkable clear concept of the adaptation and productivity of various forest soil types. These people of the wilderness were dependent for their livelihood upon game, berries, mushrooms, and other products of the forest. Wood, tree bark, fibers, sap and forest mushrooms, and other products of the forest. Wood, treebark, fibers, sap and forest herbs also played a vital part in the tribal economy. This dependence on the forest products led to an intimate understanding of the factors influencing the productivity of land, distribution of trees and vegetation, quality of wood, susceptibility of forests to fire, abundance of game and other conditions. Passage of this information from generation to generation represents the results of a multitude of collective experiences.

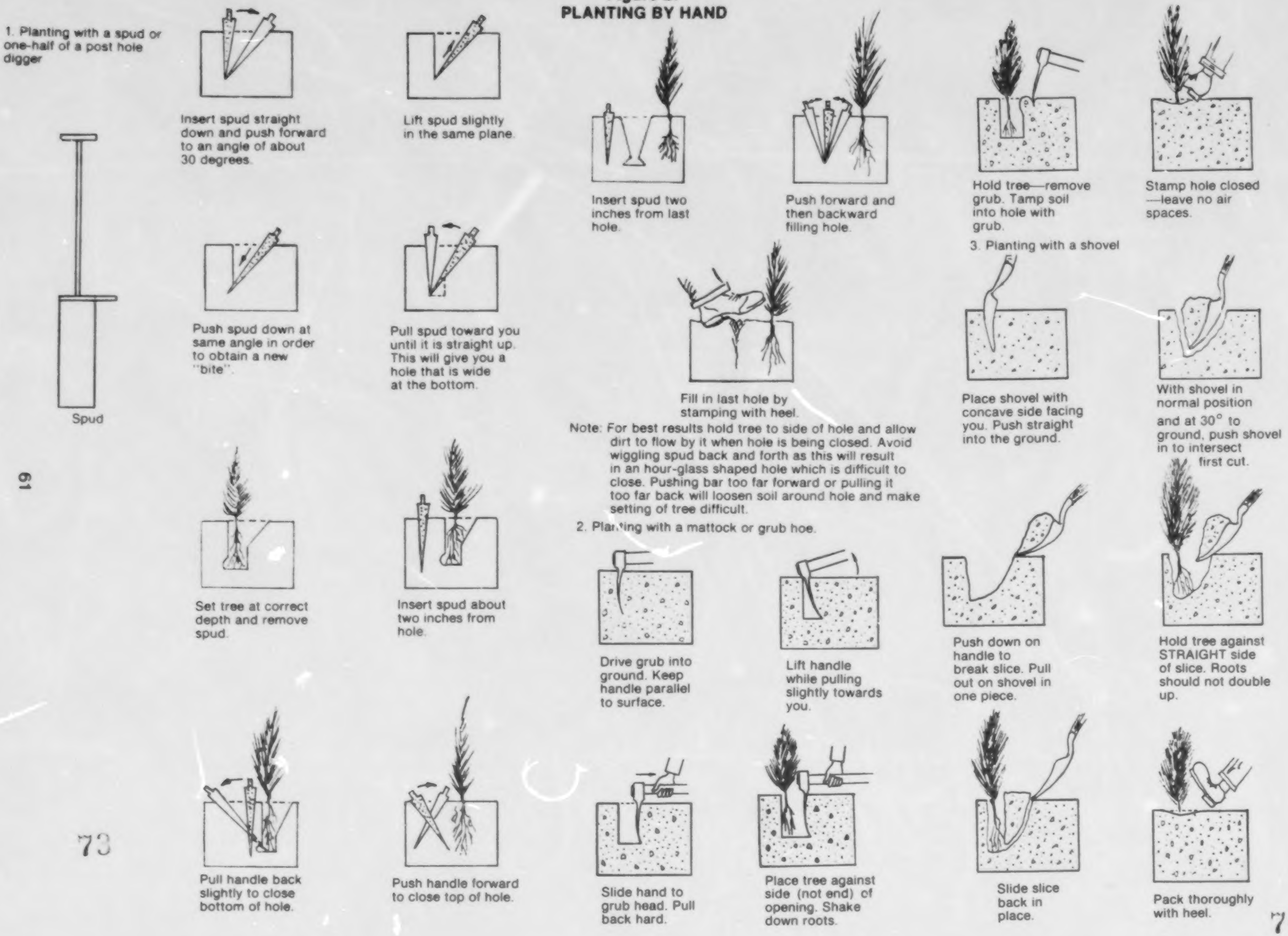
Soil Factors Influencing Forest Growth

The distribution and rate of growth of forest stands are influenced by a great many soil characteristics of a physical, chemical and biological nature.

Physical Properties

1. Depth of Soil: Several horizons may be found in some soils, but for evaluation purposes they are grouped into surface soil, subsoil and parent material. The top layer of the soil is the surface soil. Its depth varies from a few inches to a foot or more. This layer usually contains

Figure 27
PLANTING BY HAND



1. Planting with a spud or one-half of a post hole digger

Spud

Insert spud straight down and push forward to an angle of about 30 degrees.

Lift spud slightly in the same plane.

Push spud down at same angle in order to obtain a new "bite".

Pull spud toward you until it is straight up. This will give you a hole that is wide at the bottom.

Set tree at correct depth and remove spud.

Insert spud about two inches from hole.

Pull handle back slightly to close bottom of hole.

Push handle forward to close top of hole.

Insert spud two inches from last hole.

Push forward and then backward filling hole.

Fill in last hole by stamping with heel.

Note: For best results hold tree to side of hole and allow dirt to flow by it when hole is being closed. Avoid wiggling spud back and forth as this will result in an hour-glass shaped hole which is difficult to close. Pushing bar too far forward or pulling it too far back will loosen soil around hole and make setting of tree difficult.

2. Planting with a mattock or grub hoe.

Drive grub into ground. Keep handle parallel to surface.

Lift handle while pulling slightly towards you.

Slide hand to grub head. Pull back hard.

Place tree against side (not end) of opening. Shake down roots.

Hold tree—remove grub. Tamp soil into hole with grub.

Stamp hole closed —leave no air spaces.

3. Planting with a shovel

Place shovel with concave side facing you. Push straight into the ground.

With shovel in normal position and at 30° to ground, push shovel in to intersect first cut.

Push down on handle to break slice. Pull out on shovel in one piece.

Hold tree against STRAIGHT side of slice. Roots should not double up.

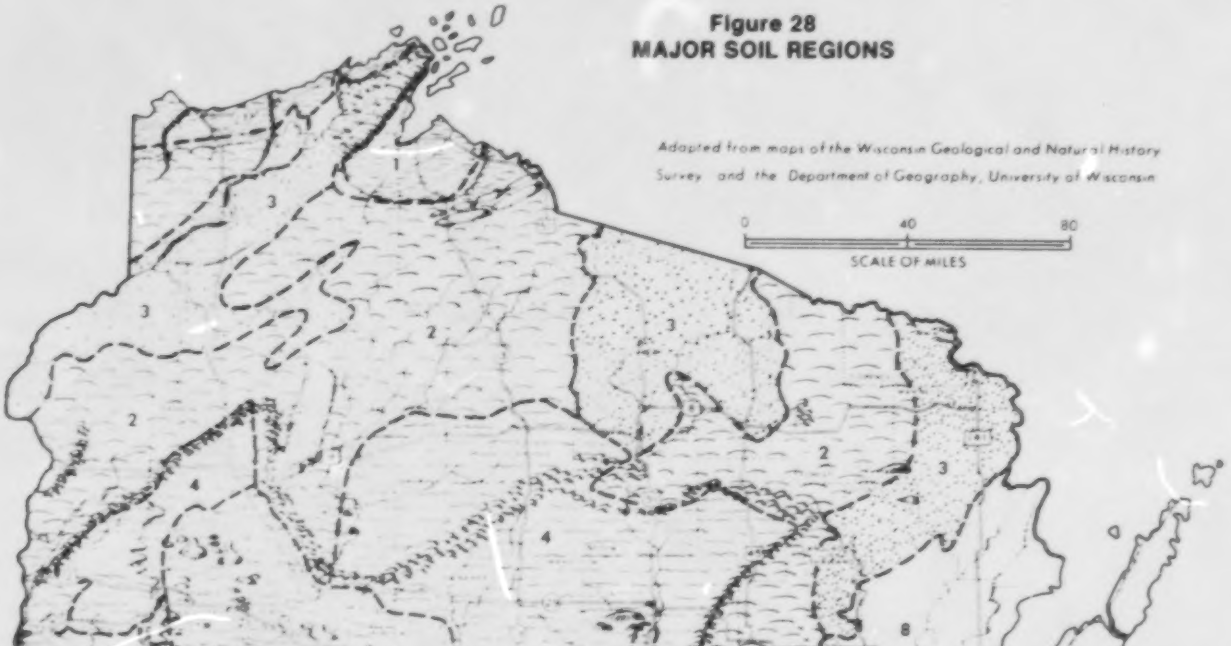
Slide slice back in place.

Pack thoroughly with heel.

the greatest amount of organic matter and available plant nutrients. Beneath the surface soil is the subsoil. It commonly contains several layers (horizons). The subsoil usually does not have much organic matter and is more compact than the surface soil.

2. Soil Texture: Texture is determined by the content of the coarse and fine soil particles. The percentage of fine particles is closely correlated with the water-holding capacity of the soil; water movement into and through the soil, and its aeration.

Figure 28
MAJOR SOIL REGIONS



Adapted from maps of the Wisconsin Geological and Natural History Survey and the Department of Geography, University of Wisconsin

1. **REDDISH CLAY LOAMS**
   Level or gently rolling.
2. **GRAYISH LOAMS and SANDY LOAMS**
   Gently rolling or hummocky, often stony.
3. **SANDS**
   Level or gently rolling.
4. **GRAYISH-YELLOW SILT LOAMS**
   Level or gently rolling, often wet.
5. **SANDY LOAMS**
   Gently rolling, hilly or steep.
6. **GRAYISH-BROWN UNGLACIATED SILT LOAMS**
   Hilly or steep.
7. **GRAYISH-BROWN GLACIATED SILT LOAMS**
   Nearly level or rolling.
8. **PINK LOAMS**
   Nearly level or rolling.

3. Organic Matter: Improves the physical properties of the soil and serves as a source of nutrients, particulary nitrogen. The percentage required for good tree growth varies with species. It is known that some of the pines grow well in soils containing less than 1 % organic matter and many hardwoods require as much as 4 %.

Chemical Properties

1. Soil Reaction-Is expressed in terms of pH values, acidity, or alkalinity. The symbol pH refers to the activity of hydrogen ions in a soil-water suspension as recorded on a potentiometer or by clorimetric means. The pH scale extends from 0 to 14 and the neutral point is represented by pH 7. Values below 7 indicate an acid reaction; values above 7 indicate an alkaline reaction. Soils best suited for tree planting in Wisconsin have a pH range from 5 to 7.

2. Essential Nutrients-Ten major elements have long been known to be essential to plant growth. The ten original elements have been supplemented by six "minor" elements bases on research findings. The major elements and their functions are:

a. Carbon (C)-a vital part of plant tissue
b. Hydrogen (H)-a vital part of plant tissue
c. Oxygen (O)-a vital part of plant tissue
d. Nitrogen (N)-a vital part in plant nutrition
e. Phosphorus (P)-a vital part in root development
f. Sulfur (S)-a vital part in root growth
g. Potassium (K)-a vital part in conversion of sugars and starches
h. Calcium (Ca)-a bonding material in cell walls
i. Magnesium (Mg)-part of the chlorophyll molecule
j. Iron (Fe)-essential in synthesis of chlorophyll

The minor elements and their functions are:

a. Manganese (Mn)-a vital part in chlorophyll formation
b. Boron (B)-a vital part in root development
c. Copper (Cu)-a vital part in plant respiration
d. Zine (Zn)-a vital part in plant enzymes
3. Molybdenum (Mo)-essential for nitrogen-fixation by legumes
f. Chlorine (Cl)-essential to healthy tissue formation

3. Air and Water: Together air and water compromise about 50% (25% each) of the volume of a given quantity of soil. Organic matter may comprise up to 5% of the volume while the balance (45%) is our mineral or inorganic soil.

Biological Properties

Soil organisms influence the development of the soil and the growth of forest vegetation. They decompose organic remains, promote formation of soil aggregates, influence the availability of nutrients, hasten the germination of seeds and, in some cases, injure or destroy living plants. Important soil and plant organisms are bacteria, fungi and algae; and animal organisms are earth worms, insects and mammals.

The Influence of Soil on Forest Growth

Although various species of trees have different soil requirements, they are generally less demanding than are root, grain and forage crops and hence will grow on soils of lower fertility. Summarizing the research that has been done on soils in relation to tree growth, and after the first few years of establishment, several general facts are evident:

1. Insofar as the general requirements for trees are concerned, available nitrogen, phosphorus, and potassium usually are not seriously deficient in forest soils. Alkaline soils (limestone particles present, reaction pH 7 or above) do not favor native pines. They are suitable for red cedar. Many hardwoods seem to grow equally well on alkaline or acid soils, but competent observers feel that most species prefer those which are slightly acid.

2. Available but not excessive soil moisture is an extremely important requisite for good tree growth. In soils subject to drought, such as sands, the percent of organic matter and the amount of silt and clay present are important because these two factors influence water-holding capacity.

3. Other physical soil properties which influence tree growth are the total depth of the A and B horizons, plasticity, and compactness of the B horizon, location on slopes, drainage, and aeration. Thus deep, friable, moist but well-drained soil is ideally suited for root development.

4. Absence of the A horizon is not so serious where there is a deep, friable, and moist soil profile. If the subsoil is compact and tight, however, the amount and depth of topsoil assumes the same importance in tree growth as it does in other plants.

5. From the above generalization, it is clear that fertility alone, as used in an agricultural sense, is not an accurate measure of soil quality desirable to produce healthy trees.

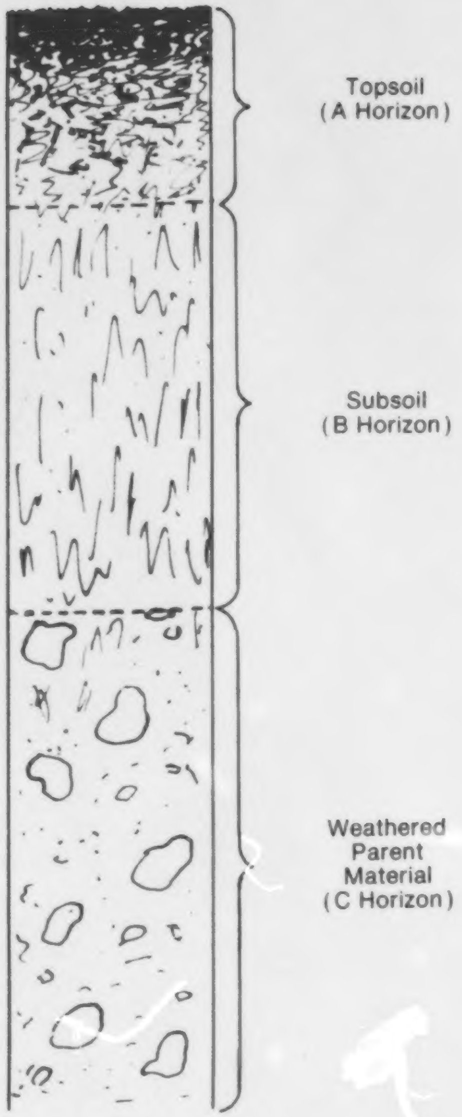
6. The crop removed from a managed woodland contains infinitely small amounts of nitrogen, phosphorus and potash; hence it is usually not recommended that these elements be replaced artificially.

Soil Sampling

The most important phase of soil analysis is accomplished not in a laboratory but outdoors and consists of soil sampling. It should be remembered that soils may vary in the horizontal as well as the vertical plane. In a study of forest soils, a cursory survey of ground cover vegetation on the area to be sampled will often delineate the varying soils present. In investigations to determine the productive capacity of the tree-supporting soils, sampling can usually be confined to the surface 6-inch layer which usually reflects the fertility of the entire soil profile.

The number of soil samples required in each particular case depends upon several conditions: size of the area, variability of the soil, purpose of the analysis, and the value of the crop. The following examples give some idea

Figure 29
SOIL PROFILE


Topsoil
(A Horizon)
Subsoil
(B Horizon)
Weathered
Parent
Material
(C Horizon)

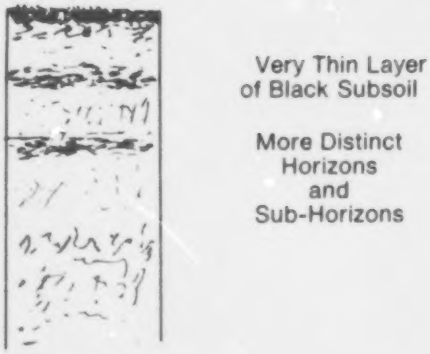
A Horizon, which is also known as the topsoil, varies in thickness from a few inches to 18 inches or more. Usually it is about 6 to 8 inches thick. Its organic matter content gives it a darker color than the other layers. Forest originated soils have a very thin layer of dark soil, only an inch or two, while grass originated soils have a thick layer of dark soil which can extend downward 12 to 18 inches or more.

The topsoil has an abundance of microorganisms, such as bacteria, fungi, algae, worms, and small insects. The more organic matter present, the greater is the microbial population.

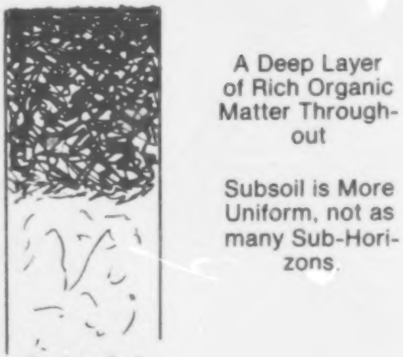
B Horizon, also known as the subsoil, is more compact than the topsoil and is usually composed of finer particles of clay. It has very little organic matter and only a few microorganisms in comparison to the topsoil. The type of subsoil has a direct bearing on the ability of the water to percolate through it and the ability of roots to penetrate into lower levels. In the B horizon are often found hard depositions of limestone, or other types of mineralization due to movement of fine particles and dissolved materials into lower levels.

C Horizon is the parent material and is not considered a true soil. Some of the rock in it has gone through a weathering process, but the process has not been sufficient enough to classify it as a true soil. In some types of soil profiles the rocky material which underlies the soil may have been caused by glaciation while the soil above it may have been brought in by wind or water from entirely different regions. In such cases the underlying material should not be considered as parent material.

Comparison of Forest and Prairie Soil


Very Thin Layer
of Black Subsoil
More Distinct
Horizons
and
Sub-Horizons

Forest Soil


A Deep Layer
of Rich Organic
Matter Through-
out
Subsoil is More
Uniform, not as
many Sub-Hori-
zons.

Prairie Soil

on the minimum number of samples needed under different conditions. 1. Soils of individual trees - one composite sample. 2. Soils of established plantations or for plantation establishment - one composite sample for each 5 acre plot. 3. Soils of a large forest area - two composite samples from each soil - type profile.

Sampling Tools

A sampling tube is the most efficient and reliable tool. This facilitates taking a six-inch core from surface soil. Also, an ordinary cylindrical spade is a satisfactory substitute; as well as, a garden trowel or other types of similar equipment.

Analysis of Physical Properties of Soils

Determination of Soil Texture

Texture refers to the relative percentage of fine and coarse soil particles. The coarse particles include stones, gravel and sand. These provide physical support to plants and play a minor part in water retention and plant nutrition. The fine soil material is made up of silt and clay. These fine particles determine the water-holding capacity of the soil, soil aeration and supply of available nutrients.

Soil Class	Silt and Clay Percentage
Sand	Less than 7%
Loamy sand	7-15%
Sandy loam	16-25%
Light loam	26-40%
Heavy loam	More than 40%

Soil texture is determined by sampling the surface layer which serves as a growing medium for trees during their critical development period. The importance of soil texture is most significant in soils with fine particles (silt and clay) of less than 20-25%.

In a field determination, soil is passed through a mesh sieve. A measured sample is mixed with a dispersing agent and water. After shaking, a hydrometer is floated in the suspension and the reading in percent is taken immediately. Equipment manufactured for this test is available from most scientific supply houses.

Determination of Organic Matter Content of Soils

In many forested areas, organic matter is synonymous with soil fertility. It serves as a home for organisms, provides nutrients and energy material, exerts a strong influence on formation of structural aggregates, retention of moisture and absorption of nutrients. In taking a core sample for organic matter determination, it is essential that a core be taken to depth of at least six inches. Complete kits for determination of organic matter are available commerically. The use of dangerous acids in this process requires extreme care on the part of the tester.

Analysis of Chemical Properties of Soil

Determination of Soil Reaction

The growth of plants is influenced by the relative content of free hydrogen and hydroxyl ions in the soil. The effect of free ions is called acidity or alkalinity and is expressed in terms of pH value. A convenient and rapid determination of pH value of soils is by use of a soil reaction test kit. Kits for this test are small and compact in size, and are available from scientific supply houses.

Suggested Learning Activities

1. Develop seedbed
2. Develop transplant bed
3. Identify insect and disease problems
4. Construct trenches and transplanting board
5. Test soil
6. Judge forest soils
7. Collect samples of forest soils
8. Determine specie variety for soil types
10. Plan and plant a windbreak
11. Fill out tree order form contract
12. Scalp or other wise prepare area for planting
13. Take pictures for school records
14. Check plantations for condition, need to release cuttings and replantings

CHAPTER SEVEN

TENDING THE FOREST

Hazards to Natural Forest Reproduction and Plantations

Hazards to young forest stands include (1) man - caused hazards, (2) vegetative competiton, (3) insects and disease, (4) animal pressures, and (5) weather.

Man-Caused Hazards

One of the more important man-caused hazards is grazing which does more damage to woodland in Wisconsin than do forest fires. Grazing animals prefer broad-leaved trees and will damage conifers if they are present. The continuous presence of animals compacts the soil and distrubs its physical structure. Forest soil must be permeable to moisture and air. When it is continuously packed, the natural permeability is lost. Research has shown that grazing sets up a continuing cycle of soil depletion and results in a deficiency in necessary plant nutrients at a time when young trees need nutrients in maximum amounts. Proper soil conditions are essential to tree growth. Growing results in a gradual deterioration of the productive capacity of the site. Other grazing damage includes the mechanical injury to surface roots, stripping of bark, and injury to reproduction and other small trees. Because of grazing, woodland soils become more compact, tree crowns become less dense and sod develops. Reproduction decreases both in quantity and quality. As these conditions progress, it becomes difficult for young seedlings to survive after germination. Those that do establish themselves do not grow at the normal rate.

Grazing hazards can be easily eliminated. All that is necessary is the installation of a cattle retaining fence to keep out livestock.

Logging

Careless logging can be an important contributor to breakage of young trees or injury to the residual stand. Responsible and experienced operators can keep logging damage to a minimum. On all logging operations in hilly terrain, a skid trail should be made along the contour (whenever possible) in order to avoid excess erosion within the woodland.

Fires

Fires are largely man-caused. They pose a constant potential threat to young forests. Plantations of recent establishment where the grass has not as yet been crowded out are especially threatened. With a single spark, years of forest planning and management can be eliminated if proper precautions haven't been taken to give the forest or plantation maximum fire protection. The term "forest fire control" includes all activities involved in keeping forest or wildland fires from getting started (prevention) and putting those out that do get started (suppression).

There are three principal phases of forest fire control. (1) forest fire prevention, (2) forest fire presuppression (making necessary plans and preparations to stop fires) and (3) forest fire suppression.

Fire Prevention

It has been said again and again that there is no honor attached to the detection and suppression of a forest fire if you could have prevented it. You have probably also heard many times, "A fire prevented is a fire that does not have to be suppressed."

Both statements plainly point out that the first step in a forest fire control program is a strong preventive effort. This requires strong public support for the prevention of wildfires.

Much time, energy and money is spent yearly in Wisconsin for forest fire prevention. Commonly known practices, such as plowing furrows around forest plantations, are an important part of prevention, but it is only a small part of the total program. Other areas of prevention of importance include:

Debris Burning

Always be sure you are complying with the forest fire laws before burning anything.

The safest time to burn is late in the day after the wind has gone down.

Always have fire fighting tools handy before you start a fire. If possible, plow a fire break around the material to be burned.

Be sure your fire is out.

YOU are responsible if your fire gets out of control. You become liable for all expenses incurred in suppressing the fire, and for all damage caused by it.

Liability for damages includes injury to young tree growth.

Incinerators

Have your incinerator inspected and approved before you use it. It may be necessary to obtain a burning permit. Check with your local forest ranger or other officials responsible for forest fire protection.

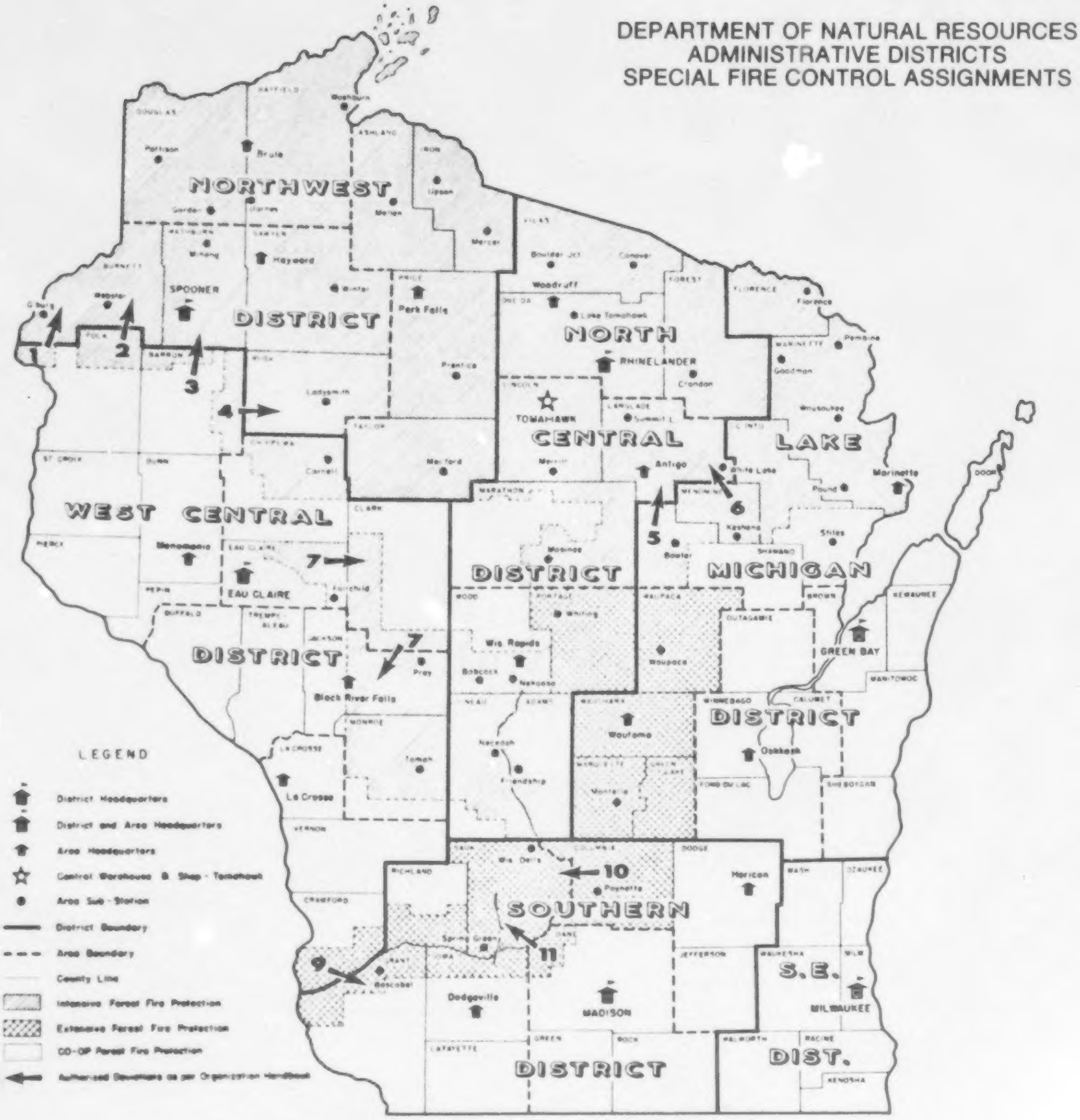
Smokers

Be sure your match is out. See that pipe ashes and cigar or cigarette stubs are dead before discarding them. Use the ashtray in your car.

Campers

Build campfires only in safe, approved, areas, away from flammable forest fuels. Never leave a campfire until it is completely extinguished. Be doubly sure that the last spark is out.

Figure 30
DNR - SPECIAL FIRE CONTROL ASSIGNMENTS


DEPARTMENT OF NATURAL RESOURCES
ADMINISTRATIVE DISTRICTS
SPECIAL FIRE CONTROL ASSIGNMENTS

NORTHWEST DISTRICT
NORTH CENTRAL DISTRICT
WEST CENTRAL DISTRICT
LAKE MICHIGAN DISTRICT
SOUTHERN DISTRICT
S.E. DIST.
Brule
Pattison
Gordon
Minong
Hayward
SPOONER
Webster
Winter
Mellen
Upson
Mercer
Park Falls
Prentice
Ladysmith
Boulder Jct.
Conover
Woodruff
Lake Tomahawk
RHINELANDER
Crandon
TOMAHAWK
Merrill
Antigo
White Lake
Florence
Pembine
Goodman
Wausaukee
Pound
Marinette
Keshena
Shiles
Medford
Cornell
Menomonie
EAU CLAIRE
Fairchild
Black River Falls
Mosinee
Whiting
Wis. Rapids
Babcock
Nekoosa
Waupaca
GREEN BAY
Wautoma
Oshkosh
Montello
Tomah
La Crosse
Necedah
Friendship
Wis. Dells
Poynette
Horicon
Spring Green
Boscobel
Dodgeville
MADISON
MILWAUKEE
1
2
3
4
5
6
7
7
9
10
11
LEGEND
District Headquarters
District and Area Headquarters
Area Headquarters
Control Warehouse & Shop - Tomahawk
Area Sub - Station
District Boundary
Area Boundary
County Line
Intensive Forest Fire Protection
Extensive Forest Fire Protection
CO-OP Forest Fire Protection
Authorized Deviations as per Organization Handbook

FIRE CONTROL—SPECIAL FIELD ASSIGNMENTS (Authorized Deviations as described in Organization Handbook)

Forest Fire Control responsibilities, personnel, equipment and facilities in the intensive and extensive fire control zones of certain counties as shown by numbered arrows on the above map are attached to other administrative units as follows:
Arrows numbered 1-2-3-4 indicate the intensive forest fire protection zones in Polk and Barron Counties, they are attached to the Northwest District. The Northwest District Director will issue supplementory instructions relating to area assignments as appropriate.

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Loggers

When refueling power saws, do so in a cleared area, free of any flammable material; then move a safe distance away before starting the motor. Flammable material should be moved away from saw cuts. Sawdust should be checked for smoldering embers before moving to the next cut. A fire extinquisher and shovel should be part of your regular equipment when using a power saw in the woods.

Protecting Buildings from Forest Fires

The following practices are recommended by the Department of Natural Resources to reduce the chance of fires starting near cabins and summer homes in wild land areas. These practices may also protect buildings from wild fires that may occur in the area.

1. Trees should be thinned out in the immediate vicinity of buildings.
2. Existing trees should have branches limbed to prevent their loss in case of fire.
3. Prune tree branches that are very close to buildings.
4. Leaves and flammable materials should be removed from under and around buildings.
5. Grass and small vegetation should be cut or mowed 200 feet around building
6. A screen should be provided for your chimney. Recommendations for screens can be obtained from your local DNR field office.
7. Keep a water supply and shovel handly in case of fire.
8. Purchase or make an incinerator for burning trash. Blueprints for an approved incinerator are available from DNR field offices.
9. Have a ladder available in case of a roof fire.
10. Check if trees are too close to power lines.
11. Pine plantations are safer with a disced firebreak around them.
12. Clear all flammable materials within five feet of outdoor fireplaces. Equip the smoke outlet with a screen and a method of controlling indraft.
13. When constructing access roads to buildings, considerations should be made to allow large fire trucks to drive in easily and turn around.

Firebreaks and Access Roads

Firebreaks are vital to the protection of conniferous plantations. A satisfactory barrier should be made at time of planting. This can be done by plowing a strip about a harrow-section wide. It can be kept open and free of vegetation by subsequent harrowings. One harrowing in the early spring and a second in July or August are usually sufficient to keep the weeds in check and mineral soil exposed. This operation must be repeated yearly to prevent loss of the trees by fire. The plantation should also be established with an "access" route around the entire planting. This route would serve as an aid in future management practices, and would enhance wildlife values. It would also help in the prevention and suppression of destructive forces that are a threat to a plantation. This "access" route should be at least 25 feet in width. Within the plantation, an "access" route of at least 18 feet should be provided at 300-foot intervals.

Forest Fire Organization in Wisconsin

Fire control areas covering an area of 17 million acres have been established in the state. Cooperative areas have also been established to cover the rest of the state. The degree of protection effort is indicated by the descriptive terms "intensive," "extensive" and "cooperative."

Burning Regulations and Permits

Burning permits may be required in any area of the state. The conditions of burning will be stated on the permit you receive. Requirements vary with location. Generally one of the following situations will apply to the place you wish to burn.

Intensive Fire Control Areas

Except for cooking or warmth, burning permits are required. They are required for areas outside of incorporated villages and cities when the ground is not snow-covered. Permits can be obtained from local emergency fire wardens and DNR field stations.

Extensive Fire Control Areas

Burning permits are required except for cooking or warmth, when the ground is not snow covered and at other times designated by the Department. Burning permits can be obtained from local emergency fire wardens and DNR field stations.

Cooperative Fire Control Areas

Burning permits are required when the town board posts the township in 5 or more public places. Burning permits can be obtained from the town chairman and other appointed wardens.

Incorporated Cities and Villages

Burning permits may be required by local ordinances. Persons wishing to burn, should contact the local government officials or fire department for information.

Another regulation requires that before any fire is started, at any time of the year, except when the ground is snowcovered, written permission must be obtained from a fire warden or forest ranger. Forms for the issuance of these permits are available from fire wardens or at department ranger stations.

Intensive Forest Fire Protection

Intensive protection is defined as the assignment of skilled personnel, specialized equipment and facilities in quantities sufficient to guarantee a high degree of forest fire prevention, detection and suppression. Efficiency and effectiveness are provided at a reasonable cost in relation to the values protected.

Extensive Forest Fire Protection

Extensive protection is defined as the limited assignment of skilled personnel, specialized equipment and facilities to provide for an adequate degree of forest fire prevention, detection, and suppression. Efficiency and effectiveness are provided at a minimum cost in relation to the values protected.

Cooperative Forest Protection

Cooperative protection is defined as giving aid and counsel, upon request or in emergencies, to the town authorities who are legally responsible for forest fire prevention, detection, and suppression activities in the territory outside the boundaries of established intensive or extensive fire control areas. Town chairmen, by virtue of their office, are town fire wardens. Costs of forest fire prevention and suppression, incurred by a town chairman, acting in his capacity as town fire warden, shall be paid by the town.

Fire Control Organization

District

Each district director is responsible for the overall Department of Natural Resource program.

Area

Each area supervisor is responsible for the overall Department of Natural Resource program. In intensive and extensive fire control areas, the fire control program is directed by the area forest ranger. In cooperative areas, the area forester is responsible for the fire control program.

Ranger Stations

Ranger stations have been strategically located throughout organized areas and staffed with trained, fire control personnel and specialized equipment, to suppress all types of forest fires. Burning permits are issued at all ranger stations.

Emergency Fire Wardens

Approximately 1,500 emergency fire wardens are appointed throughout the organized fire control areas to issue burning permits and assist in other fire control activities.

Protection of Forest and Wild Land Areas

Under provisions of the Conservation Act, protection of Wisconsin forest and wild land areas from destructive fires, is a principal responsibility of the Department of Natural Resources. The responsibilities include: prevention, detection, suppression of fires, and enforcement of laws relating to protection of forest lands.

Forest Fire Control

"Forest fire control" is a term commonly associated with prevention, detection and suppression of uncontrolled fires in forest or wild land areas. It is defined as that combination of activities necessary to keep fires from starting but, if they do start, to extinguish them quickly so that the burned area and damage will be held to an acceptable minimum.

Forest Fire Control Objectives

Due to the failure of people to fully understand the awesome potential of wild fire in forest or wild land areas, fire occurrence continues. Statistics indicate that most forest fires are caused by human carelessness. The best way to keep forest fire damage down to an acceptable level, is to prevent as many forest fires as possible.

Forest Fire Prevention

Destruction of our valuable natural resources by forest fires, can be reduced through programs soliciting cooperation in preventing forest fires. This is being done through education and application of regulatory laws pertaining to the use of fire in forest or wild land areas.

Natural Resources Board Jurisdiction

The Natural Resources Board of Wisconsin is vested with power, authority and jurisdiction in all matters relating to the prevention, detection and suppression of forest fires outside the limits of incorporated villages and cities in the state, and to all things necessary in the exercise of such power, authority and jurisdiction.

Forest Fire Definition

The term "forest fire," means uncontrolled or running fires occurring on forest, marsh, field, cutover or other lands or involving farm, city or village property and improvements incidental to these fires.

Fire Control Responsibility

The Natural Resources Board shall direct and give suitable instruction and obtain reports as directed, from the entire fire warden force of the state, whether in officially established fire control areas or elsewhere. It may also move about or concentrate the fire warden force as occasion demands.

Fire Control Agreements

The Board may enter into arrangements or agreements and cooperate with town boards, county boards or committees thereof, with individuals, concerns, corporations or associations, for the purpose of improving the protection against forest fires.

The Natural Resources Board may, upon request from the fire chief of a city or village, or the chief executive thereof, supply assistance within the limits of their resources in suppressing fire within the confines of the said municipality.

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Organization Procedure

Natural Resources Board

The Natural Resources Board has authority to make surveys to determine the need for and the extent of protection necessary from forest fires in any part of the state.

Department of Natural Resources

Fire control areas may be established, and skilled personnel, special equipment and facilities may be obtained, to effectively prevent, detect and suppress forest fires.

It is the responsibility of the Department to organize the administrative units, develop plans, and recruit and train employes. They must also be aware of any inventory hazards or risk conditions. Other work necessary to guarantee the successful operation of the type of forest fire control endeavor being applied in that particular area is also the Department's responsibility.

Fire Control Duties and Responsibilities

Forest rangers, emergency fire wardens, town chairmen and other authorized persons, must take prompt measures to prevent and suppress forest fires and have authority to hire men, equipment, and facilities to fight fires.

Any able-bodied citizen must assist in fire suppression when called on to do so.

Forest rangers and others properly authorized have power to make arrests without warrant for violations of laws relating to the protection of forest lands.

Forest rangers, emergency fire wardens and other properly authorized persons, may go on any lands in performance of their official duties and do any work they deem necessary to suppress fires without incurring any liability.

Methods of payment are authorized and established to cover all types of services necessary in fire suppression work.

U.S. Forest Service — All fire control within the national forests is assumed by the U.S. Forest Service with the exceptions of that area in Taylor County. State Laws as well as federal regulations apply on these two million acres of national forest land in the State.

How Forest Fire Danger is Measured

Most people can tell reasonably well how dry vegetation is by observing some natural signs present. That was once the way the fire fighters determined forest fire danger-but no more.

Now the fire manager uses such factors as temperature, relative humidity, fuel moisture, precipitation, wind velocity, and condition of ground vegetation-dry, green, or in between these two. Analysis of the interaction of these variables indicates to the fire manager what he has to prepare for in the way of men and equipment to cope with the current fire situation.

Thus he knows what to do about burning permits, detection requirements, and other items of importance relating to his job of preventing and suppressing forest fires.

Information on the current forest fire danger in forest and wild land areas is often given on radio and TV programs. The fire danger rating chart will help you to understand what the situation is where you live.

Fire Danger Rating Chart

Extreme

Explosive conditions. Fires start easily, burn fiercely and crown readily. Often very difficult or impossible to control during the day. Burning is not recommended.

Very high

Very dangerous conditions. Fires start easily, spread very rapidly, crown and spot. Very difficult to control. Burning is not recommended.

High

Dangerous conditions. Fires start readily from a match or sparks, spread quickly, and spot readily. Difficult to control. Burning is not recommended.

Moderate

Fires start from a match or burning embers, spread quickly in dry grass or leaves. Burn with extreme caution.

Low

Fires will start from an open flame, spread slowly, and in absence of wind, tend to go out. The safest time to burn.

Fire Detection

In the intensive and extensive protection areas, fire lookout towers and airplanes, both radio equipped, are used for detection.

During times of poor visibility, because of fog, haze or smoke, it is sometimes necessary for additional patrolling by automobile.

Detection in the cooperative areas involves local landowners contacting their town chairman, sheriff or volunteer rural fire department.

How and to Whom to Report a Forest Fire

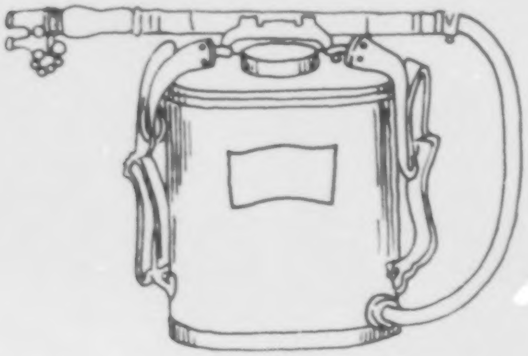
Fire should be reported to the nearest forest ranger, fire warden or local resident. If you are a stranger in a community, go to the nearest phone, or, if no phone is nearby, notify the nearest farmer, storekeeper or tavernkeeper. The telephone operator will also be able to connect you with the proper authorities.

When reporting a fire, be sure to include this information:

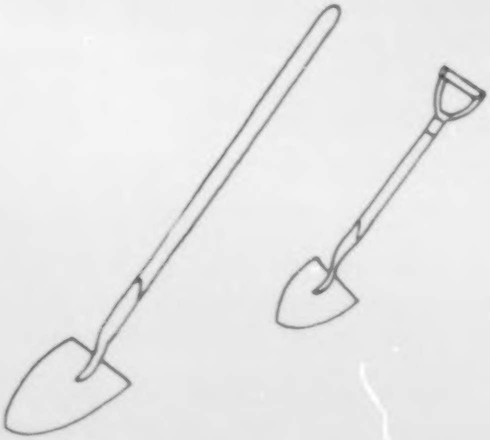
1. Location of fire.
2. Size.
3. What is burning and what is in immediate danger of burning.
4. How hard the fire is burning.
5. How many men, if any, are fighting the fire.

Common fire fighting hand tools and their use

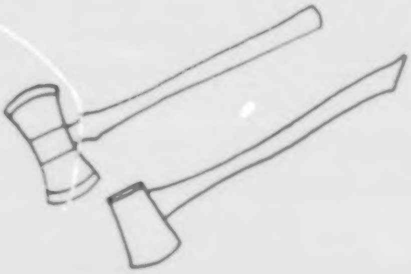
The common tools used in fire fighting are pictured and described as follows:



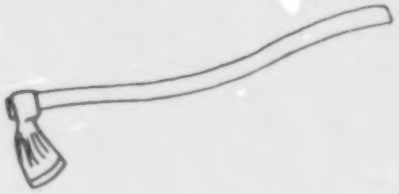
Back-Pack Pump — Carries about five gallons of water used to reduce the fire so that a line can be constructed. It also puts out a fire by placing water in the proper areas.



Shovel — Either short or long handled, are used for fire line construction by shoveling duff and humus to one side until mineral soil is reached in line construction. It is used to follow up plowing or other digging, in order to obtain a clean fire line.

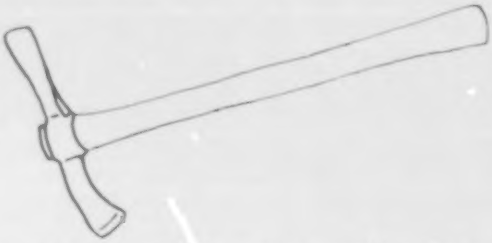


Axe — Used to cut material for fire line clearing, snag felling, etc.

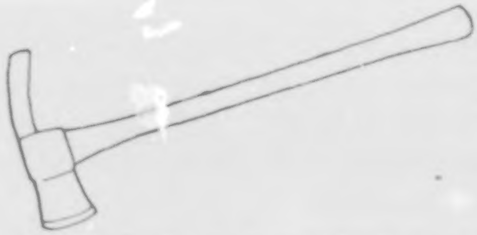


Grub Hoe — Used for digging and grubbing in soil, humus, roots, and decayed logs in constructing fire lines.

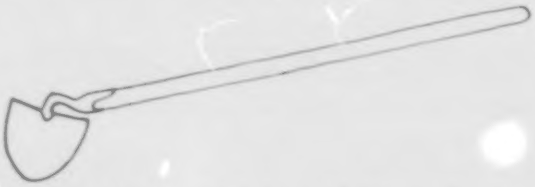
Crosscut Saw or Chain Saw — Used in bucking logs that lie across the fire line. It is also used in felling snags.



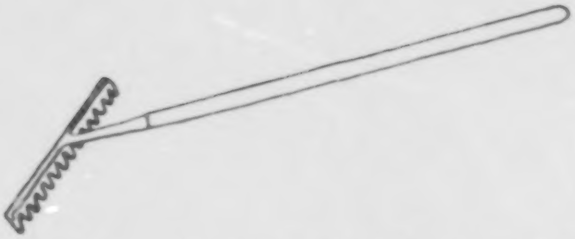
Cutter Mattock — Used much as a combination axe and grub hoe. The sharp edge is used as an axe, while the other edge is used for grubbing in fire line clearing and construction.



Pulaski Tool — Similar to a cutter mattock except that it is somewhat lighter and sharper and used for lighter work in fire line clearing and construction.



Finn Hoe — Used as a grub hoe for lighter work, mostly in duff and humus where rocks and roots are not too numerous.



Fire Rake — A heavy rake used in the construction of a fire line where the material to be handled is light, (such as leaves and small twigs,) and mineral soil can be reached by such raking.

Fire Suppression

Factors affecting the behavior of a forest fire.

1. Relative humidity.
2. Winds.
3. Forest fire fuels.
4. Topography.
5. Temperature.
6. Fuel moisture.

Influence of relative humidity — Extremely low humidities will result in high inflamability of forest fuels. The degree of inflamability becomes greater as the low humidity period continues. Fire can start and spread at relatively high humidities. Normally, however, fires spread only slowly when the relative humidity is above 50 per cent. Between 40 and 50 per cent, fires tend to pick up and, with unfavorable conditions, (pertaining to fuels and wind,) may spread rapidly. During the fire seasons, when the relative humidity drops below 40 per cent, the fire danger becomes acute.

Winds — They are of outstanding importance in gauging the rate and direction in which a fire will spread and in determining the inflammability of forest fuels.

Fire fuels — Flash or critical fuels are those which, under normal conditions, are susceptible to easy ignition and rapid combustion. They include: dead vegetative materials, needles, light litter, small branches, dead leaves, grasses and other light fuels and ferns.

Heavy or slow burning fuels include the remaining dead materials, which by reason of their structure or arragement, are covered, and will not burn rapidly. In many instances, they do not burn at all until the overlying materials are consumed. They include: humus, heavy limbs, logs and decaying wood.

Green fuel embraces all the growing forest vegetation such as foliage, brush, etc. These materials, while living, have a high moisture content and do not constitute a severe hazard.

Topography — The steepness of the slope is always a big factor in governing the spread of a fire. The steeper the slope, the more rapidly the fire advances. A fire can go up a hill faster than it can go down.

Temperature — Air temperature has a very important effect on the behavior of a forest fire and also upon the moisture content of fire fuels. Fires burn more severely at high temperatures because warm fuels ignite and burn more quickly.

Moisture — The inflammability of all forest materials is governed primarily by their moisture content. This is one of the most important factors in determining the speed with which a fire will burn. It is governed by the amount and circulation of air through the fuels.

Kinds of Fires

There are three classes:

Surface fires — Those which run over the surface of the ground, feeding in the top layer of dry, loose litter, grass, needles, weeds and small bushes, the outer surface of logs, etc. They usually are intensely hot and spread rapidly. Fires in second growth — aspen, grass types, old ferns, fern types, etc. — are typical.

Ground fires — Those which consume the thick layers of decaying humus and other vegetation which are more compact and usually contain more moisture than the top layers of loose litter. Ground fires tend to spread slowly or smoulder, are most persistent and require a long time to burn out and extinquish. Thick mats of needles and deep humus, as found in old timber, peat bogs, etc., are typical.

Crown fires — Those in which the foliage of the trees is consumed. This is the most difficult type to control. Dense coniferous stands lend themselves readily to this type of fire.

What to do before a fire gets started.

Three things a landowner can do to protect his land from fire:

1. Establish firebreaks and access ways.
2. Reduce hazards by disposing of dangerous fuels.
3. Organize fire control crews and locate fire control tools in a handy place.

Persons who start uncontrolled fires are responsible for the damage they cause. The state or the town may recover the costs of suppression.

Fire Regulations and Restrictions

Setting Fires and Backfires

Any person who shall set a fire or assist in the setting of a fire, including a back fire, on any lands in this state not his own or under his control, shall totally extinguish such a fire before leaving it. Upon failure to do so he shall, upon conviction, be fined not more than $100, or imprisoned not more than 2 months, or both.

Allowing Fire to Escape

Any person who sets a fire or assists in the setting of fire, including a back fire, upon his own land or land under his control and who allows such fire to escape and become a forest fire shall be fined not more than $100, or imprisoned not more than two months, or both.

Unlawful Fire Setting

Any person who shall willfully and maliciously set fire on any land shall be deemed guilty of a felony and upon conviction shall be punished by a fine of no more than $1,000 or by imprisonment in the state prison for not more than two years.

Driving Game with Fire

It shall be unlawful for any person to set or assist in setting a fire upon marsh or other land in the state for the purpose of driving out game birds or animals. The possession of fire arms upon any marsh while it is on fire shall be prima facie evidence of such violation. Any person who violates the provisions of this section shall be punished by fine of not more than $200 or by imprisonment not more than 3 months or by both.

Liability for Fire Suppression Costs

Any person, firm or corporation who shall set fire on any land and allow such fire to escape and become a forest fire, shall be liable for all expenses incurred in the suppression of such fire by the state or town in which such fire occurred. Such claim shall be paid within 60 days and if not paid within such time, the state or town may begin an action thereon at any time within 2 years.

Civil Liability for Damages

The liability of persons for damages is not limited to the destruction of merchantable timber. It may also include the value of young or immature forest growth.

The United States, the state, the county or private owners, whose property is injured or destroyed by fires, may recover, in a civil action, double the amount of damages suffered, if the fires occured through willfulness, malice or negligence. Persons or corporations causing fires, shall be liable to the state in an action for debt, to the full amount of all damages done to the state lands and for all expenses incurred while fighting such fires.

Negligent Handling of Burning Material

Whoever handles burning material in a highly negligent manner, may be fined not more than $200 or imprisoned not more than 6 months or both.

Burning material is handled in a highly negligent manner if, under the circumstances, the person whould realize that he creates an unreasonable risk and high probability of death or great bodily harm to another or serious damage to another's property.

Destroying Property

It is illegal for any person to destroy, deface, remove or molest any forestry equipment or property or to disfigure any forest fire sign, poster or warning notice.

Refusing Assistance on Fires

It is illegal for any able-bodied citizen to refuse to render assistance on a forest fire.

Cutting Forest Products: Notifying County Clerk

Before anyone cuts any type of commercial forest products, except for fuel wood or from clearing land for agricultural purposes, a written notice must be made each year to the county clerk indicating when, where, what and how much cutting is to be done.

Timber Trespass

Penalties are provided for timber trespass and timber theft. In addition, persons unlawfully cutting forest products shall be liable to the owner for double the amount of damages suffered.

Unlawfully Cut Timber Products

Forest products unlawfully cut from public lands may be seized by agents of the Department of Natural Resources or other authorized law enforcement officers and may be sold by the agency in whom ownership is vested.

Christmas Trees

Christmas trees and other evergreen or coniferous by-products may not be cut for sale unless a written consent from the landowner, indicating where cutting was authorized, is in possession of the person cutting or transporting such forest products. Such Christmas trees or by-products may not be transported or shipped outside the county where cut unless a Christmas tree dealer's license has been obtained and each shipment properly tagged before being transported. Forest rangers or other properly authorized persons may inspect Christmas tree cutting or transportation operations at any time.

Slash Disposal

Anyone cutting forest products or clearing rights-of-way is required to dispose of all resulting slash up to a specified size and within certain limits, along public roads, railroad rights-of-way and property lines of adjacent owners.

Slash deposited in any lake or stream must be removed if it is in the public interest to do so, or the state may do the work and charge costs incurred to the responsible party.

Railroad Fire Prevention Responsibilities

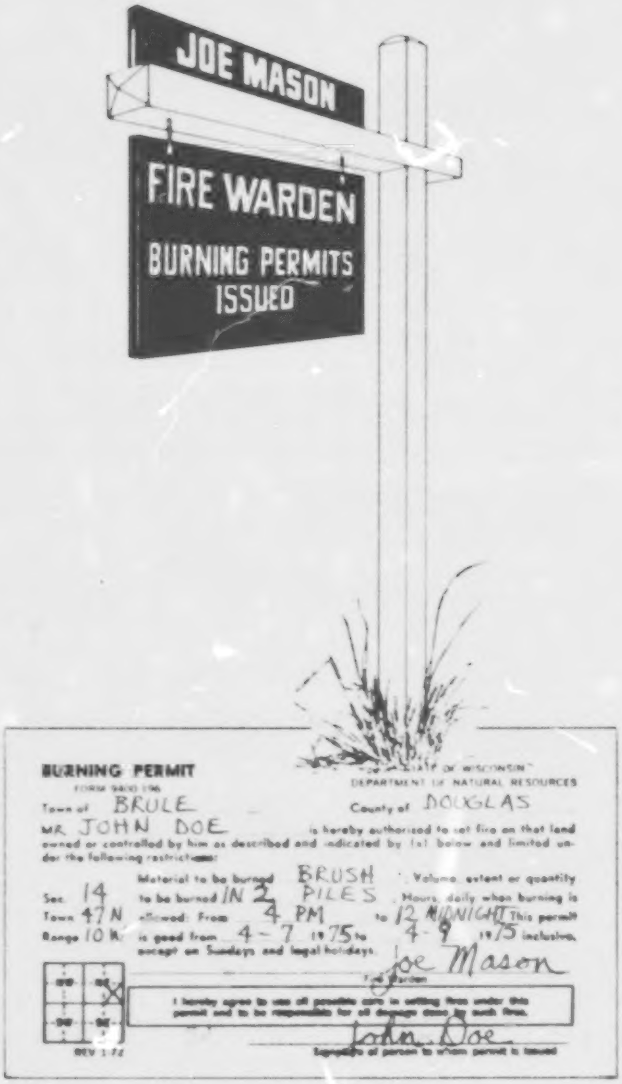
The Department fire prevention supervisor is authorized to reject from service immediately any locomotive, tractor, or other engine that is not equipped with adequate fire prevention devices.

Right-of-Way Clearing

All railroad companies are required to clear their rights-of-way of flammable materials annually.

Permits

Burning permits are required in the intensive and extensive protection areas and in the cooperative protection areas when so ordered by a town board. Issuance of a permit does not relieve the permittee from damage caused by the fire should it become uncontrolled.



BURNING PERMIT
FORM 9400-196
STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

Town of BRULE County of DOUGLAS

MR. JOHN DOE is hereby authorized to set fire on that land owned or controlled by him as described and indicated by (x) below and limited under the following restrictions:

Sec. 14 Material to be burned BRUSH . Volume, extent or quantity
Town 47 N to be burned IN 2 PILES . Hours, daily when burning is
Range 10 W allowed: From 4 PM to 12 MIDNIGHT This permit
is good from 4 - 7 1975 to 4 - 9 1975 inclusive, except on Sundays and legal holidays.

Joe Mason
Fire Warden

I hereby agree to use all possible care in setting fires under this permit and to be responsible for all damage done by such fires.

John Doe
Signature of person to whom permit is issued

REV 1-72

Assistance

All able-bodied citizens can be impressed to assist forest fire suppression.

Causes of Forest Fires

Most fires are caused by people. There are so many people using Wisconsin's forest and recreational areas today that it is not possible to contact all of them. This great mass of users of the outdoors keeps changing from day to day, which makes the fire prevention problem even more complex. No one really intends to destroy the beauty of our forest or damage our natural resources, but it is difficult for persons not acquainted with fire control work to realize the tremendous destructive potential of wild, uncontrolled, running fire.

You can help prevent forest fires by being extra careful when you are hunting, camping, hiking or otherwise enjoying our wonderful outdoors.

Fire Occurrence Periods

Forest fires occur in every month of the year. There are peak seasons when fire occurrence is most likely to take place.

One season occurs in the spring months, usually from March until June, with the highest occurrence being in April and May after the snow has left the ground and the vegetation is still in a dead stage.

Another season starts in late July and reaches a peak danger period in late September and early October.

Always be careful with fire and be especially careful during these particular dangerous dry period.

Vegetative Competition

Vegetative competition is a very serious hazard and accounts for much mortality in natural stands and plantations. Many shrubs such as gray dogwood, blackberries, raspberries, hazel and prickly ash cut off sunlight from germinating tree seeds and hinder their development. Oak and aspen sprouts and taller interior weed species are also a serious hazard to the development of coniferous reproduction or plantings. Grass too can often be very stiff competition to planted trees and probably accounts for more loss in plantations than any other cause.

Vegetative competition acts in several different ways upon forest reproduction:

1. Shading out light-demanding trees such as red pine, yellow birch and oak.
2. Depleting soil moisture and nutrients.
3. Acting as a mechanical obstacle in preventing growth of reproduction.

Valuable natural reproduction and plantations can be released from this vegetative competition by the removal of the undesirable overstory either by cutting, girdling, or herbicides. In areas where it appears that sod is choking the trees, it may be necessary to scalp the sod away or kill the sod with an appropriate herbicide.

As a general rule, light-demanding trees should be given a complete release whereas shade-demanding trees can be released gradually.

The shrubby overstory can have a definite part in hindering white pine reproduction. With pine, limited controlled grazing can help prevent the shrubby overstory from becoming established. Then during pine seed years (every four to seven years) the seed falling on the ground will have a chance to germinate and develop without coping with the shrub overstory.

Insects and Diseases

Forest Insects

Insects are among the most abundant life forms in the forest and exert a continuous influence through all stages of the growing and mature stand. They may directly affect forest trees by outright killing, decreasing growth, or reducing the usefulness of the final products. In addition, the attack may produce indirect effects which do not kill the trees, but render them more susceptible to other insects or to disease. Disrupting forest management practices and the maintenance of undesirable cover types are also examples of the indirect effects of insect attack. Insect injury is classified into several types on the basis of the part of the tree attacked and the method of feeding.

Insects and disease cause tremendous losses to forest reproduction. Plantations are especially vulnerable to insect attack because they are grown with bushy crown and are generally of one species and age class.

Several inspections of plantations and valuable reproduction may be necessary during a summer so that insect infestations may be discovered at an early stage and appropriate action taken for control.

Much of the loss due to insects and disease can be minimized or prevented by following sound silvicultural practices such as:

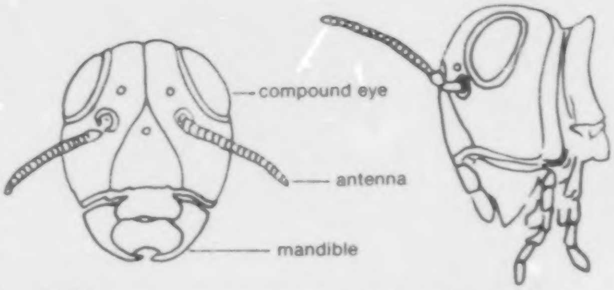
1. Maintaining stands of good vigor.
2. Establishing stands within the natural climatic range and on the proper sit
3. Avoiding stands of a single species.
4. Removal of diseased trees in early thinnings.

Defoliators — The entire leaf or needle may be consumed and the tree completely defoliated, or only a part of the leaf destroyed depending upon the insect species concerned and their abundance. The seriousness of defoliation depends upon the tree species attacked, the completeness of defoliation, and the frequency at which it occurs. A single complete stripping of pines, spruces, firs, and cedars (conifers) usually results in their death. Partial defoliation is reflected in growth reduction. Broadleaf trees, such as maple, oak and aspen, are more capable of withstanding foliage loss and mortality does not occur until stripping has been repeated annually for several seasons. Partial defoliation of both conifers and hardwoods also results in the increased susceptibility of the trees to bark and root inhabiting insects. This is the most serious effect of non-fatal defoliation. The forest tent caterpillar, jack pine and spruce budworms, and the sawfly larvae are typical defoliators.

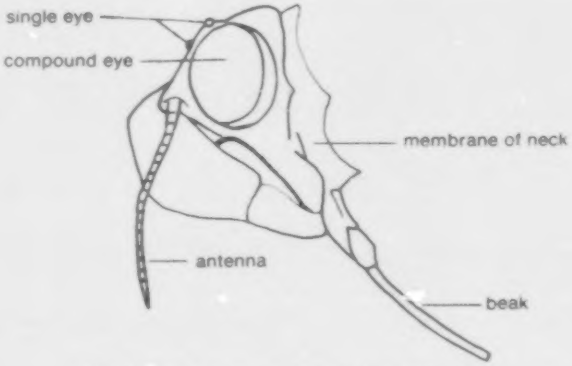
Leaf Miners — The leaf miners feed between the upper and lower surfaces of leaves or inside the needles of conifers. When the attack on the latter is severe growth reduction and mortality may result; on hardwoods, resistance to other insects and disease is reduced. An example of this type of injury is produced by the activities of the birch leaf miner.

Sucking Insects — Sucking insects reduce tree vigor by the withdrawal of sap to the extent that the tree or a portion of it dies. These insects may introduce toxic substances which cause growth malformations, or their feeding punctures may serve as points of entry for disease organisms. Many insects of this group also injure trees by means of punctures made during egg laying activities. Among the sucking insects causing economic loss in forest stands are the plant lice (aphids), scales and spittlebugs.

Basic types of insect mouthparts



Head and mouthparts of typical chewing insect, front and side views.



Head and beak of a sucking insect (cicada)

Twig and Stem Feeders — Although these insects seldom kill trees, they cause stunting and distortion of both coniferous and hardwood trees by boring into the buds, twigs and small branches. In addition, height growth is frequently reduced to such extent that tree harvest is prolonged several years beyond the planned rotation. The white pine weevil, the European pine shoot moth, and the oak twig pruner are examples of insects in this group.

Bark Beetles — The bark beetles must be considered among the most dangerous of forest insects. By tunneling into the bark and cambium they are capable of killing healthy trees as well as trees weakened by some other cause. In Wisconsin forests, their greatest threat is to trees which would otherwise recover from the effects of defoliation, sap withdrawal or drought. In addition to consuming wood, the bark beetles introduce wood staining and wood rotting fungi withich further reduce the value of the wood for paper and lumber. The most common Wisconsin species include the pine engraver and the red turpentine beetle.

Wood Borers — Like the bark beetles, these insects are more important as enemies of weakened trees, or logs stored in the forest. The borers can be further subdivided as follows: (a) the flatheaded or metalic wood borers, (b) the roundheaded or longhorned wood borers, and (c) the ambrosia beetles. The young grubs of the borers feed in the cambium region for a time and later penetrate the solid wood. Wood thus infested is rendered unfit for lumber. Substantial volume losses also occur in wood used for pulp and paper. Ambrosia beetles bore in the sapwood of weakened and recently cut trees, and in unseasoned wood stacked in lumber yards. The wood surrounding the tunnels is stained by the ambrosia fungi, which the beetles cultivate in the burrows. Infected wood is weak, and often useless as lumber and tight cooperage. The bronze birch borer typifies the flatheaded wood borers, while the sugar maple borer and locust borer are examples of the longhorned beetles.

Gall Formers — Seldom do the gall insects cause the death of trees, but indirectly reduce the growth or stunt otherwise healthy trees. Galls may be formed on leaves, small as well as large twigs, and even on the main stem and roots. This ability to irritate certain parts of trees and cause gall formation is not limited to any specific group of insects or mites, and only rarely are control measures necessary.

Cone, Seed and Nut Insects — The flowers, fruits, nuts, and seeds of practically every forest tree species may be attacked and destroyed by insects. Since reforestation and the future supplies of timber depends on an ample supply of fertile seeds, this group of insects is of prime importance; however, comparatively little is known about them. The acorn weevil, cone moths and beetles, and the seed chalcids are responsible for the loss of many cones or seeds.

Root and Root Collar Feeders — Trees, particularly nursery stock, may be killed, stunted, or lowered in vigor by such insects as white grubs, wireworms, root collar weevils, and cutworms. Many mealy bugs and aphids also feed on root systems.

Carriers of Disease — Insects play a very important role as carriers of disease pathogens. They may accidently introduce them into wounds caused by some other agent, or carry the organism into their own burrows and feeding areas. In a few cases, the insect may be dependent on the disease-causing fungus for food while the fungus is dependent on the insect for its dissemination. Long distance transmission of oak wilt occurs when an insect feeds on a fungal mat and is then attracted to a fresh wound in a healthy tree. Dutch elm disease also is spread by insects, particularly the smaller European elm bark beetle.

Control of Forest Pests

The injurious insects are, with few exceptions, native and have been around for many years. It is virtually impossible to completely eradicate either these, or the well established foreign-pests. Under forest conditions, a certain number of insects occur normally and natural control factors maintain the populations at endemic levels. When conditions become especially favoriable for a particular insect pest, its numbers rapidly increase and an outbreak occurs, requiring artificial controls.

Natural Control Factors

Insect activity is limited a temperatures above or below an optimum. At temperatures above 120 degrees, only few insects survive, and this makes possible the control of many species of bark and wood boring insects by exposing infested logs to direct sunlight. Low winter temperatures, or severe late frosts (occuring after new growth of the trees has begun in the spring) also kills many insect pests.

Moisture has both a direct effect on the insects and an indirect effect through its influence on the pests-hosts. Inadequate precipitation may lower the tree's resistance to bark beetle attack; flooding or excessive soil moisture also may weaken the trees.

Severe rainstorms have provided excellent control by knocking defoliating larvae from foliage. Windstorms, however, may provide additional breeding sites for bark and wood inhabiting insects that are dependent on the dead wood of broken tops and branches.

Pest Control

Carefully inspect plantations at least twice each year (spring & summer). Check for outbreaks of insects, disease or other damage. Report outbreaks immediately to the local Department of Natural Resources forester. He will be able to recommend practices to reduce further damage to the plantation. In general, a good management program involving release, thinning and pruning will keep the plantation in a healthy, vigorous condition, best able to withstand pest outbreaks.

Artificial control of insects in plantations may be necessary. The establishment of solid blocks of a single tree species or two encourages the development of unnaturally high insect populations which may have to be kept in check by spraying.

Entomologists and pathologists, people knowledgeable in insects and diseases of forest trees, are available to assist in problems that crop up in plantations. Contact your local forester if you have insect or disease troubles and he will notify the specialist of your problem.

Control measures vary by causal agent. These will be prescribed by a specialist and the actual control program is the responsibility of the landowner. More in Section on Protection.

Insects, like other living things, have natural enemies which prey upon them and hold them in check. Such birds as nuthatches, chickadees, creepers, warblers, kinglets and many others destroy countless numbers of defoliating and wood inhabiting insects each year. The meadow mouse, white footed mouse, moles, shrews, voles, chipmunks, and squirrels play important roles in the destruction of forest insects which spend part of their life in the soil. Although little is known about the real importance of parasitic nematodes, certain species attack bark beetles, wood borers, soil inhabiting grubs, lepidopterous larvae and grasshoppers.

Many species of insects and mites are distinctly beneficial in that they feed on harmful species. Most native forest insects, with the possible exception of borers and other forms which feed inside the host plant, are attacked by insect parasites. All stages of an insect from egg to adult may be attacked, although as a rule, the larvae and pupae are most beneficial forms are themselves parasitized. This hyperparasitism may be occasionally carried to the second or third degree making the host-parasite relationship extremely complex. The effectiveness of parasites and predators is difficult to measure. Their success is influenced by factors such as the character and habits of the host insect, the population density of the host, the presence of alternate hosts, the degree of hyperparasitism the conditions affecting hibernation, etc.

Silvicultural Control of Forest Pests

Under virgin forest conditions, no checks were placed on the activities of destructive agents other than those imposed by nature herself. Fires, as well as insect and disease outbreaks, developed, spread, and eventually ran their course. The whole process, although wasteful, seldom resulted in the permanent destruction of the forests over large areas. Natural checks were imposed and regenerative processes came into play.

With more intensive forest management and the development of control methods, attention was turned to preventive control of forest insects and diseases. In a managed forest, the principal objectives of pest control are to regulate conditions for maintaining natural balance between the destructive insect population and their natural enemies, between the disease caused tree mortality or degradation. These objectives may be attained more fully in the future through application of silvicultural practices in growing stands where conditions unfavorable for insect development are maintained and greater resistance to insect and disease attacks is obtained. This would involve such measures as (1) the removal of susceptible trees, and the regulation of density and composition by means of periodic salvage or improvement cuts and thinnings; (2) the regulation of environmental factors through drainage and density; (3) the selection of insect or disease resistant varieties and species of trees; (4) careful seed selection (5) site selection; (6) adjustment of cutting cycles and methods; and (7) rotation of crops.

Chemical Control

Direct controls with chemicals are employed when other methods of control fail. Forest pest epidemics often appear suddenly in a localized area rendering preventive control measures useless. It then becomes necessary to suppress the destructive pest population with a chemical before severe damage results.

Chemicals have found greater use in controlling insects than diseases in the forest. Currently, research is developing chemicals to effectively reduce losses from oak wilt and white pine blister rust. Practical use of chemicals in tree disease control, however, is still limited to problems affecting shade and ornamental trees.

Insecticides used against forest insects are of two main types: contact poisons which kill insects upon contact with their external integument; and stomach poisons which cause death following ingestion and absorption in the insect's digestive tract. Stomach poisons are used against insects with chewing mouth parts. They swallow the poison while feeding on their natural food to which the insecticide has been applied. Chewing insects include the large group of forest defoliators. Insects with sucking mouthparts which feed on internal juices of their hosts must be controlled with contact sprays. Sucking insects include the aphids and spittlebugs which feed on juices of leaves, needles, or twigs. Often an insecticide will have both properties as a contact or stomach poison and may be used in combating a variey of pests.

There are many methods for applying insecticides, and literature on this subject is quite extensive. Aircraft have been effectively used in controlling widespread forest pest infestations. Infestations on only a few acres may be controlled more feasibly with mist blowers, hydraulic sprayers, or simple knapsack sprayers.

Growth Impact from Forest Pests

Together insects and disease are the most destructive agents in our commercial forests. National estimates compiled by the U. S. Forest Service show that insects caused greater mortality of growing stock and sawtimber than any other destructive agent. Tree mortality alone, however, does not represent total losses sustained through destructive pests. Insects and diseases not only kill trees, but cause extensive growth loss within the commercial forest by reducing tree vigor, increasing cull percent, or deteriorating the site. Estimates show that disease pests caused greater growth loss to both growing stock and sawtimber than any other destructive agent.

Forest insects and diseases are beneficial to the extent that they thin overdense young stands or kill overmature and decadent trees, but beyond this they injure useful trees and sometimes develop devastating epidemics. How to prevent or control insects and utilize much of the vast amount of timber they kill every year are major forestry problems as yet largely unsolved.

The Protection of Forests From Disease

Trees, no less than other large forms of life, are subject to disease that reduce their growth, destroy their usefulness or cause death. The threat of disease is ever present from the time a tree emerges as a seedling to the end of its useful life.

In the virgin forests that covered Wisconsin this threat was lessened because, through centuries of interaction, a certain degree of natural balance between the trees and their disease enemies had been achieved. The early settlers of Wisconsin, in their need for land, shelter, fuel and communications, upset this balance by cutting, clearing, burning and planting. Exotic tree species from foreign lands were brought in. The forests were so changed from their original, natural state that over most of the forest land of Wisconsin the once stabilized relations no longer exist and the danger of disease has increased with a corresponding increase in loss of timber.

With the new tree species or their products coming from abroad came new diseases to our state. White pine blister rust on infected pine seedlings and the Dutch elm disease and its insect carriers on elm logs brought in from Europe. Losses from native diseases that have become epidemic are also cause for concern. Fomes annosus, root rot in thinned coniferous plantations, is a potential threat to conifer planting in the state. Records indicate the presence of many tree diseases in Wisconsin. Not all are equally important but the aggregate loss of trees from them has been tremendous.

Most of the losses are not from diseases of the spectacular, epidemic type but rather from the many relative inconspicuous diseases at work in and on leaves, bark, wood, roots, needles, seedlings, saplings and old trees. Losses from disease must be guarded against if our forests are to continue to supply the various wood products we need.

Tree diseases are of two types, parasitic and nonparasitic. Parasitic diseases are caused by living infectious agents as fungi viruses, nematodes or mistletoe.

Among the nonparasitic diseases are such disorders as sunscald, winter injury, drought injury, nutritional excesses and deficiencies and injury from pollution.

Fungi cause most of the major losses from disease in forest trees. They produce leaf spots and defoliation, wilts, blights, cankers, galls, heart rot and root diseases. Trees that are weakened by fungi often are more susceptible to windthrow and to attack by insects.

Not all fungi in the forests are harmful; many fungi contribute to the health and growth of trees by converting the fallen leaves, twigs, and other forest debris into humus, an important part of forest soil and source of nutrient elements for tree growth. Others combine with the tiny seedling roots on some trees to form special absorbing bodies called mycorrhizae, which are believed to enable the tree to take up nutrients from the soil more effectively than they would otherwise be able to do. Through the production of humus, fungi tend to create a soil reaction that is unfavorable to the disease fungi that attack roots of seedlings and young trees.

Diseases and fungi causing deterioration are commonly spread by wind, water, insects and bird life. Soil fungi causing root rots and wilts may be carried on wheels of vehicles or the feet of man or animals.

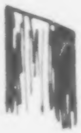
The effective control of forest diseases must be based on a sound knowledge of them and of the forest environment under which they occur. Both direct and indirect methods of control are used. Direct methods include the use of sprays, dusts and soil treatments, the removal and destruction of affected trees or parts, the prescribed use of fire and the removal of the alternate host. Sprays and soil treatments are used in state nurseries to protect seedlings against disease and sprays and dusts are used to destroy the insect carriers of disease of shade trees. Eradication is important when a disease occurs in a specific area. The white pine blister rust offers an example of a disease that can be controlled through the removal of the alternate hosts: currants and gooseberries.

Indirect methods of control involve the proper timing of cutting, pruning, the control of stand compostion to give mixtures of species instead of pure stands and the development and use of disease-resistant varieties.

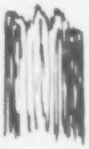
Animal Pressures

Rabbits, deer, squirrels, mice and porcupines all constitute hazards. Rabbits are particularly bad in oak stands and on white pine. Deer eat natural reproduction of all species. Squirrels strip the bark on sugar maples. Squirrels and porcupines always seem to strip the best and more dominant trees. Mice cause considerable damage to forest reproduction during the winter. The damage primarily is that of girdling the trees by stripping about the ground line.

The rodents, such as rabbits, mice and squirrels, make a sharp cut as indicated on the following sketch. On the other hand, deer make a tearing sort of cut, as indicated.



Rodent Cut



Deer "Tearing"

Weather

Snow, sleet, hail and high winds are known to cause considerable damage to the young forest. Snow and sleet causes damage by breaking branches and stems. Hail is especially severe on young conifers by stripping the trees of their needles and injuring the bark.

Winter sunscald can be damaging to trunks of young maples and yellow birch trees where they have been made subject to exposure. Winter injury is also prominent at times on small conifers by drying the needles during warm periods in winter. The needles transpire but the water cannot be replaced because the root systems are frozen. This injury is seldom fatal unless the buds also dry up.

Prolonged drought is another weather hazard that can be particularly damaging to newly established plantations.

Suggested Learning Activities

1. List fire hazard areas in the forest.
2. Identify damage to the forest caused by disease, insects, fire, or animals.
3. Establish and maintain firebreaks.
4. Select and mark trees for cutting.
5. Prune and shape selected trees for later sale as Christmas trees.
6. Carry out release work in plantations.

Management Practices Which Influence Growth Rates

Intermediate Cuttings

Intermediate cuttings are prescribed management operations in an immature forest aimed at the improvement of that forest. A farmer increases the yield of his corn crop by cultivation; the yield of a forest can be increased by judicious intermediate cuttings.

It must be emphasized that immature forests vary in size from small samplings to sawtimber and are in contrast to mature forests which are ready for a final harvest as we have discussed.

Intermediate cuttings are classified into six practices depending upon the primary objective. Clearing, improvement cuttings, liberation cutting, releasing thinning and pruning, salvage and sanitation cuttings and timber stand.

Improvement cutting

An improvement cutting is a cutting made in a stand past the sapling stage to remove the poor form, defective, and inferior species which are competing for growing space. This cutting is similar to cleaning except that it is carried on in pole and larger size timber.

Improvement cutting is the most common intermediate cutting practice in Wisconsin forests today. Millions of acres of forest land, particularly the hardwood pole stands, can use an improvement cutting. Where this work is done, the residual forest is composed of fast growing, higher quality, higher valued species of good potential.

The products so removed may be saleable depending on distance to a market. Many improvement operations will pay for themselves, whereas in some areas an investment in labor is required.

Liberation cutting

A liberation cut is the removal of large spreading "wolf" trees and low valued overstory species which are hindering the development and growth of the young stand beneath. The term "release" cutting is synonymous and probably more descriptive.

Wolf trees are large spreading trees of any species occupying excessive crown space. These trees are limbly and of poor merchantable height. Removal of these trees is recommended because the space occupied can be devoted to growing a great deal more usable wood for the owner.

Liberation cuttings are common to release a high-valued conifer from under a low-valued species such as scrub oak or poor quality aspen. Overtopped plantations or natural conifers are slow growing and are liberated to accelerate their growth rate.

The release may be partial or complete depending upon the conifer involved. The complete removal of the overtopping trees in one cut may result in sunscald, in which case the overstory should be removed in two or more cuts. The complete release of sapling or smaller white pine is not recommended since open grown white pine is an invitation to insect infestation by the white pine weevil.

Plantation Management

Release, Thinning and Pruning

Release, thinning and pruning are a major part of good management practices. Production of quality useable timber in the woodlot is dependent to a great extent on the spacing of the trees in the stand with close spacing being the key factor in obtaining high volumes.

Close Spacing

One of the reasons for close spacing in the establishment of a plantation is to crowd out or suppress grass, weeds, and brush so that the trees may have the sole use of soil mositure and nutrients. Another important reason is to develop trees with clean stems and good form.

Where trees are grown at an excessive spacing interval, they are inclined to become heavily branched with live lower branches persisting for many years. The height growth, too, may be less than that of trees spaced closer. In the end then, one is likely to have trees with heavily branched stems and of poor form. With closer spacing the branching is finer, the lower limbs die sooner, and the height growth may be somewhat better. What one is actually after is a tree whose stem as nearly as possible resembles a cylinder. A tall slender stem with a form close to that of a cylinder will have much more volume than a short stem that more nearly resembles the shape of a cone. (Figure 32.)

Pine Plantation Management

Release, Thin, Prune

Forest plantations usually need one or all of the following three practices releasing, thinning and pruning.

1. Release—Removing or killing undesirable trees that are over-topping and competing with planted trees. Pine overtopped by undesirable hardwoods, for example, may be only four or five feet tall 25 years after planting. Free growing trees of the same age may exceed 35 feet.

2. Release planted red and jack pine from lower quality trees such as scrub oak, aspen, black locust and box elder that are over-topping the plantation wholly or in part. This practice is not recommended for white pine. This release may take the form of cutting, girding, poisoning, or ground or aerial spraying with suitable herbicides. Ask your forester about the cheapest and most effective method to use.

3. Thinning—A cutting in a plantation which produces saleable wood products and increases the growth rate of remaining trees. Trees must be thinned when they become too crowed. As trees grow, they require more space. Thinning is generally applied to conifers. By proper thinning a landowner:

a. gains an early return on his investment.
b. speeds the growth of remaining trees.
c. reduces insect and disease outbreaks.
d. improves the health and beauty of the plantation.
e. improves wildlife habitat.

Pine forests, you may recall, are generally evenaged and require increasing crown space as the forest grows larger. Thinning is merely anticipating nature's method

Figure 31
SITE INDEX CURVES

ROTATION AGE OF ASPEN (POPPLE) ON DIFFERENT SITES

The height at a given age reflects the suitability of that particular site to the aspen and is used to predict maturity. Premature harvest or allowing the species to become over-mature results in reduces new yields per acre.

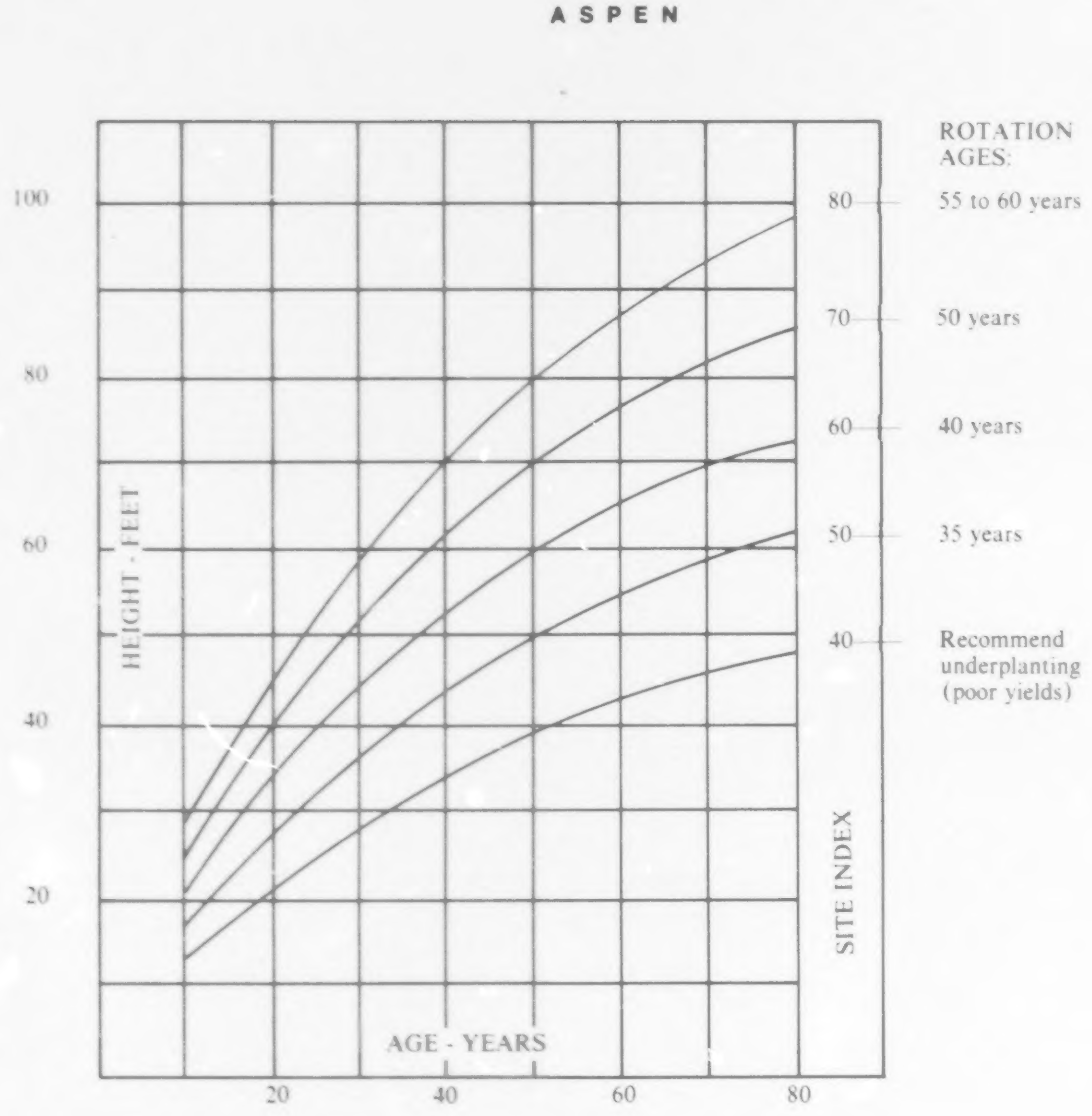
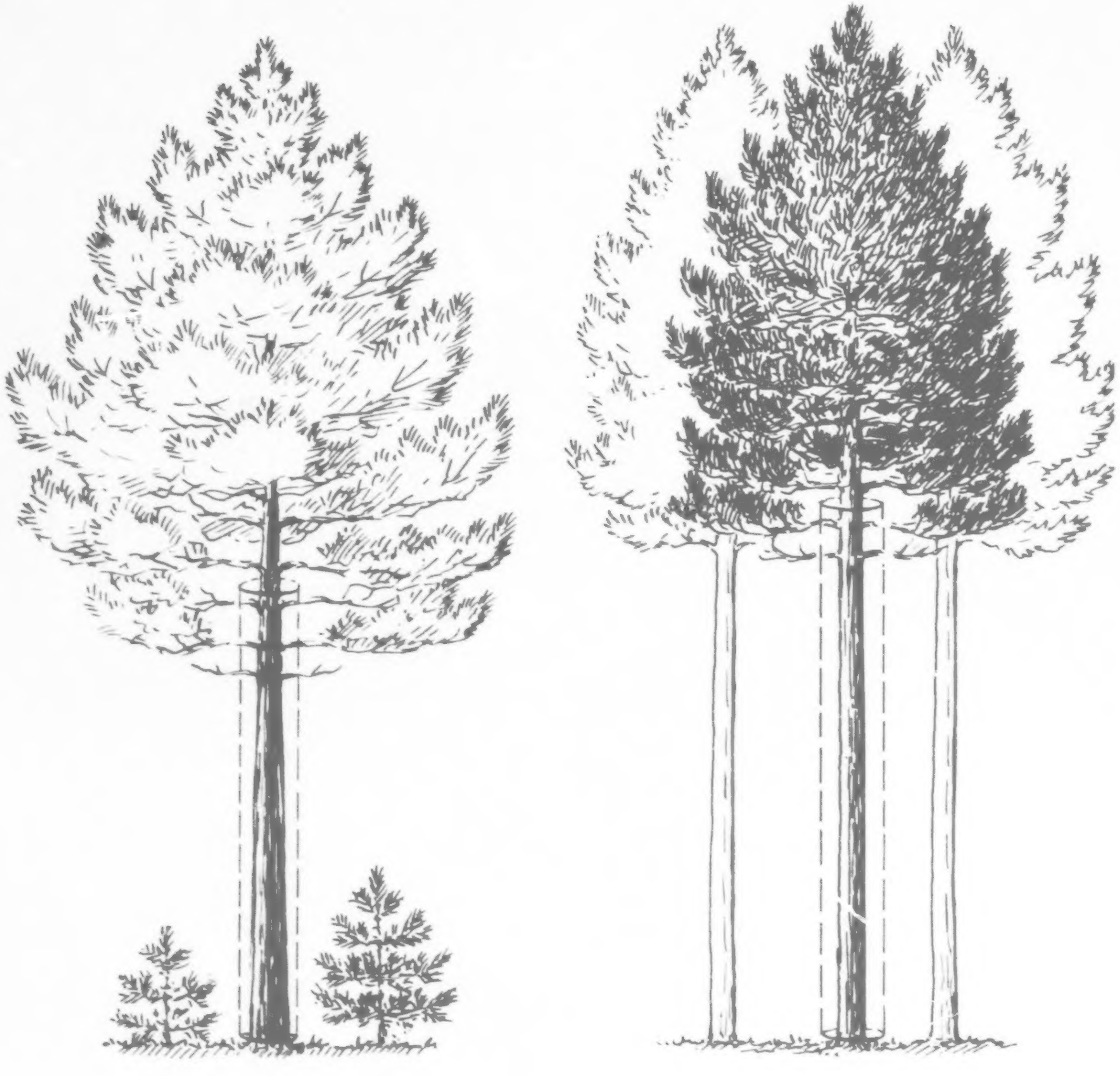


Figure 32
COMPARISON OF THE FORMS OF OPEN-GROWN AND CLOSELY-GROWN TREE TRUNKS



of "shading out" some of the trees which fall behind, and to cut these trees before they prohibit crown expansion within the forest. Periodic thinnings, not to exceed 10 years, maintain a high growth rate on the residual timber and increase production through the harvest of what would normally be lost in natural mortality.

A thinned stand of pine maintains fewer trees of larger size than an unthinned stand of the same age. The larger dominant trees are left as "crop trees" in contrast to the removal of the large mature trees in the selection harvesting of mature hardwood.

Why are the larger pine left in thinning whereas the larger mature hardwoods are cut? The answer to this question is contingent upon maturity. Thinning is carried on only in immature stands and favors the fastest growing, most productive timber. Selective cutting applies only to mature all-aged forests.

Technical advice should be obtained to determine the volume of wood to be removed in a thinning.

Thinning may or may not result in merchantable products depending upon the size of the trees and the available markets.

Thin all species of pine trees when they become too crowded. Table 14 shows the recommended number of trees per acre at various average diameters.

Table 14

Average diameter breast height	Trees per acre	Approximate Spacing Between Trees (Feet)
4"	1,000	6 to 7
6"	450	10
8"	200	15
10"	180	16
12"	130	18
14"	95	22

Determine average diameters by sampling 25 to 50 trees at random in the plantation. The number of trees per acre can be determined by counting the number of trees on a typical acre. An acre measures 208 feet square.

Selecting trees to be removed can be a complicated task. In even-ages plantations of pure red pine, row thinnings are sometimes prescribed by foresters for the first thinning if the arithmetic works out properly. For example, a 6-inch average diameter plantation may have 750 trees per acre. From the table we find that only 450 trees should be occupying the acre. Hence, a thinning removing every third row will benefit all trees that remain and reduce the number to 450 per acre.

Thinning, however is required in order to maintain or increase the growth rate. One can recognize a plantation in need of thinning by the following:

1. A possible slowdown in height growth.
2. Dead limbs on more than one-half of the stem.
3. A decrease in diameter growth as shown by increment borings.
4. Crowns of the taller trees interlaced and competing with each other for light.

Thinning objectives and results

When the above indications of a slowdown in growth rate are recognized, a thinning should be planned. The objective of the thinning is to remove a part of the trees and give the remaining trees a chance to resume normal growth. Otherwise a life and death struggle will exist between all trees and may result in stagnation of the stand.

If a tree is to put on the maximum of additional wood, the crown must have room for development. In any thinning operation the better trees should be left for future crops and a space of several feet opened up around their crowns by removing less desirable growing stock. As a further guide to spacing thinnings, refer to Chapter 5, Table 6.

The first thinning, depending upon the initial spacing, may or may not pay for itself in usable or marketable wood products. Products from the first thinnings can be used for posts and pulpwood. Later thinnings at 5- to 8-year intervals will yield additional pulpwood, poles and eventually small sawlogs.

The diameter growth response to a thinning may not be immediately apparent at breast height; however, additional and increased diameter growth is taking place in the upper portion of the stems. It simply means that the trees are attempting to correct their form and develop stems that will closely resemble cylinders. When the better form has been attained, additional diameter growth will appear evident in the lower portion of the stems.

Thinnings principally remove trees which in the unthinned stand eventually die in the struggle for existence and may decay before the crop is harvested. Thus, thinnings save what otherwise may be a total loss. In addition, an actual increase in the volume growth will follow because of the more vigorous condition and better crown development of the individual trees in a properly thinned stand. Improved soil conditions and a greater amount of available nourishment also contribute to increased production. The systematic use of thinnings may increase the total amount of usable wood produced by 50 percent or more over that produced in an unthinned stand.

Pruning

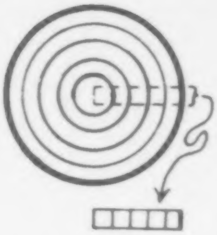
Pruning is the removal of lower branches from the trunk of standing trees to increase the quality of sawlogs to be cut in the future. Pruning as it is used in forest terminology is not to be confused with pruning shade or ornamental trees.

By removing the lower branches, the wood added to the trunk of the tree will be kept knot free. The "clear" lumber which can be produced from these logs is more valuable than knotty lumber.

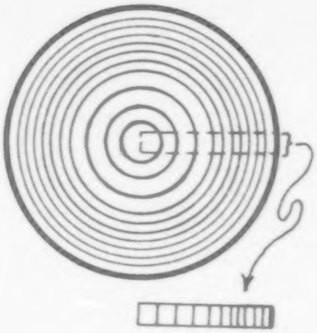
Such trees are commonly referred to as "crop trees." They are relatively free of defects, including knots. Knots are the result of limbs extending from the trunk of the tree. If these limbs are removed at an early age, when the trunk and limbs are small in diameter, the wood will grow over the wound and produce clear-grained wood. Pruning is generally limited to trees which will eventually be harvested for sawtimber, veneer, or other products requiring large and high quality logs. Since hardwoods prune themselves naturally, artificial pruning is seldom used.

Trees should be pruned to a minimum of nine feet to allow for an eightfoot log with a one-foot stump. Pruning up to 17 feet is very desirable. The top one-third of the trees should not be pruned; for reduction in growth may result from lack of live needle bearing branches. The number per acre to prune depends upon the time and money which can be devoted to this operation. At least 100 trees per acre should be considered with an optimum of about 250 and, if time is available, all of the trees may be pruned.

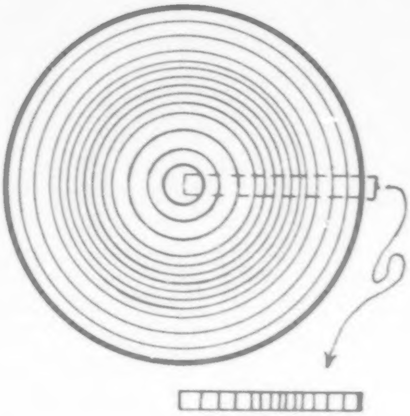
Figure 33
ILLUSTRATIONS OF TREE CROSS SECTIONS AND INCREMENT BORER
Cores Showing Changes in Rate of Growth of Plantation Trees.



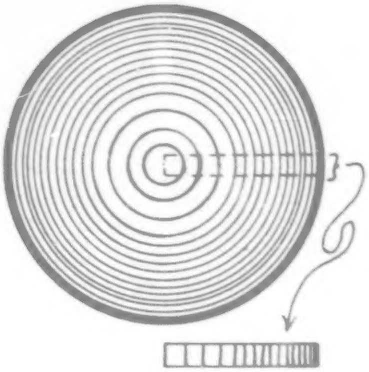
1. Normal growing plantation tree.



2. Same tree several years later in need of more growing space. Note slowdown in diameter growth.



3. Same tree several years after a thinning. Note an increase in diameter growth.



4. Tree of the same age in an unthinned plantation. Note exceptionally slow growth - plantation should have been thinned several years ago.

A small handsaw or pole mounted saw is used to remove the branches as close to the trunk of the tree as possible to hasten healing of the wound. Using an axe to remove the branches, or leaving a stub projected from the trunk, delays healing and may result in an infection of wood rotting fungi. Portable (power pack) saws are also being used extensively for pruning.

It is best to prune in fall or winter using a saw or pruning shears—never an axe. Prune as close to the trunk as possible; never leave a stub.

Red, White, and Jack Pine

Don't prune trees on the outside edge of a plantation if there are open areas adjacent to the plantation. Such a pruning allows undesirable drying winds to blow through the trees and over the forest floor. If there is danger that a surface fire might spread into low branches in the outer row, it may be desirable to prune lower branches up to about 4 feet.

Scotch Pine

Scotch pine has a large number of insect enemies, especially on sandy soils in Wisconsin. The tree rarely has value for any product other than Christmas trees because of insect damage.

Except under very unusual conditions, Scotch pine should be harvested as soon as possible. Clear-cutting is recommended. Release, thinnings and pruning are not recommended.

After the area is cleared it should be allowed to "lie fallow" for two years before replanting to reduce populations of insect enemies. Volunteer seedlings of Scotch pine should be eliminated and the area planted to a better species.

Mixed Pine Plantations

Many of the plantations in Wisconsin and lake states are not pure stands of one species. There are often mixtures of two or more species of pine and other conifers such as spruce, cedar and balsam.

Detailed recommendations for each possible mixture would require more space than is available. Mixtures frequently require special techniques that can best be prescribed by a professional forester.

Some rules of thumb on mixtures, however, follow:

1. Scotch pine with poor form should be removed.
2. Spruce grown in mixture with pine will probably be overtopped by the more rapid juvenile growth of the pine. Such plantations will require specialized thinning procedures to maintain spruce in the stand.

In individual tree selection thinnings, trees to be thinned should be marked before they are cut. Remove slow-growing and poorly formed trees before removing vigorous, high-quality trees. The temptation is usually just the reverse-taking the best trees first. It should be resisted because such a practice seriously damages the ability of the stand to remain healthy and productive.

Thinnings should be spaced at about 10-year intervals. Professional foresters use a measure known as "basal area" when determining the amount of thinning required. Their system of measurement is more accurate than the average diameter and number of trees per acre method described here. Seek out the advice of a forester before engaging in a large-scale thinning operation. He will be able to save you time and money . . . perhaps even your plantation.

Prune about 150 red and white pine trees per acre (17' x 17" spacing) which you have selected as final crop trees. These trees will be harvested for lumber and other high-quality products when the stand approaches maturity. The pruned trees will not be cut until they are at least 12 to 16 inches in diameter. Pruning is not recommended for jack pine.

The chosen crop trees should have the lower limbs pruned away so that knot-free lumber, poles, and piling will result. Pruning should proceed to at least 17 feet above the ground in one or more stages. Trees should not be pruned over one-half their total height at any one time, but may be pruned the full 17 feet by the time the trees are 34 feet tall.

The earlier the pruning, the better. If a tree is over 8 inches in diameter, pruning will have very little effect on ultimate value of the tree.

Only the straighter and more vigorous trees should be chosen for pruning as final crop trees.

Some landowners prefer to prune all the trees to at least 8 or 9 feet above the ground. Since many of these trees will be thinned for pulpwood, such pruning is not absolutely necessary because knots are not degrading in pulpwood.

But pruning all the trees does have other benefits:

1. Reduces fire hazard.
2. Simplifies the work of pulpwood cutters, in that they do not need to limb as many pulp sticks.
3. Makes the plantation more accessible for marking trees that should be thinned, and for locating crop trees.
4. Opens area for recreational use.
5. Salvage cutting

Salvage cutting is a cutting to utilize injured or dead timber damaged by fire, insect, disease or wind. All intermediate cuttings in immature stands are aimed at increasing the quality and quantity of growth with the exception of salvage cutting.

A salvage, as the name implies, is merely the utilization of timber to prevent financial loss and buildup of insect and disease problems.

Cleaning or Weeding

A cleaning cut is a cutting made in the sapling stage (under four-inch diameter) for the removal of poor form, defective, and inferior species which are overtopping or threatening to overtop superior species. The purpose of a cleaning is to improve the character and composition of a sapling stand. This cutting represents an investment since no merchantable products are obtained.

Weed and Brush Control

On sites where the young trees are in danger of becoming smothered with competing grass, weeds or

Figure 34

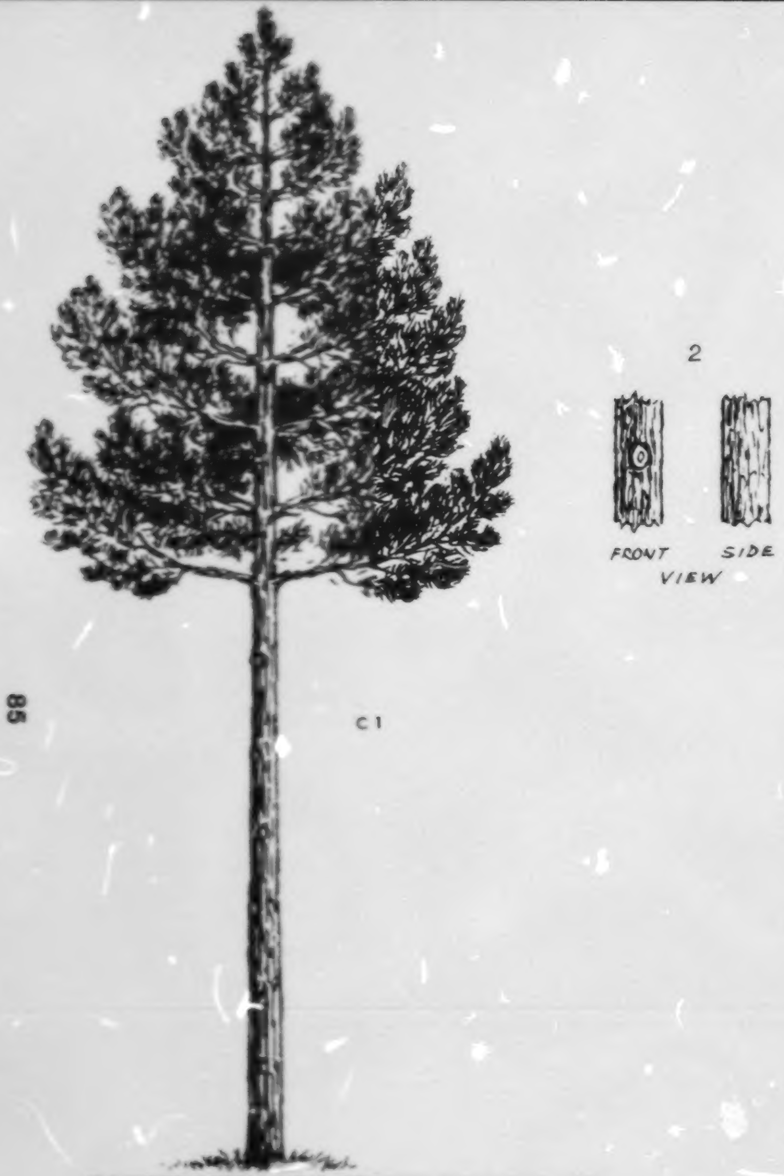


ILLUSTRATION OF A PROPER PRUNING JOB

1. Pruned to correct height.
2. Branches cut off flush with stem without wounding or injuring bark.

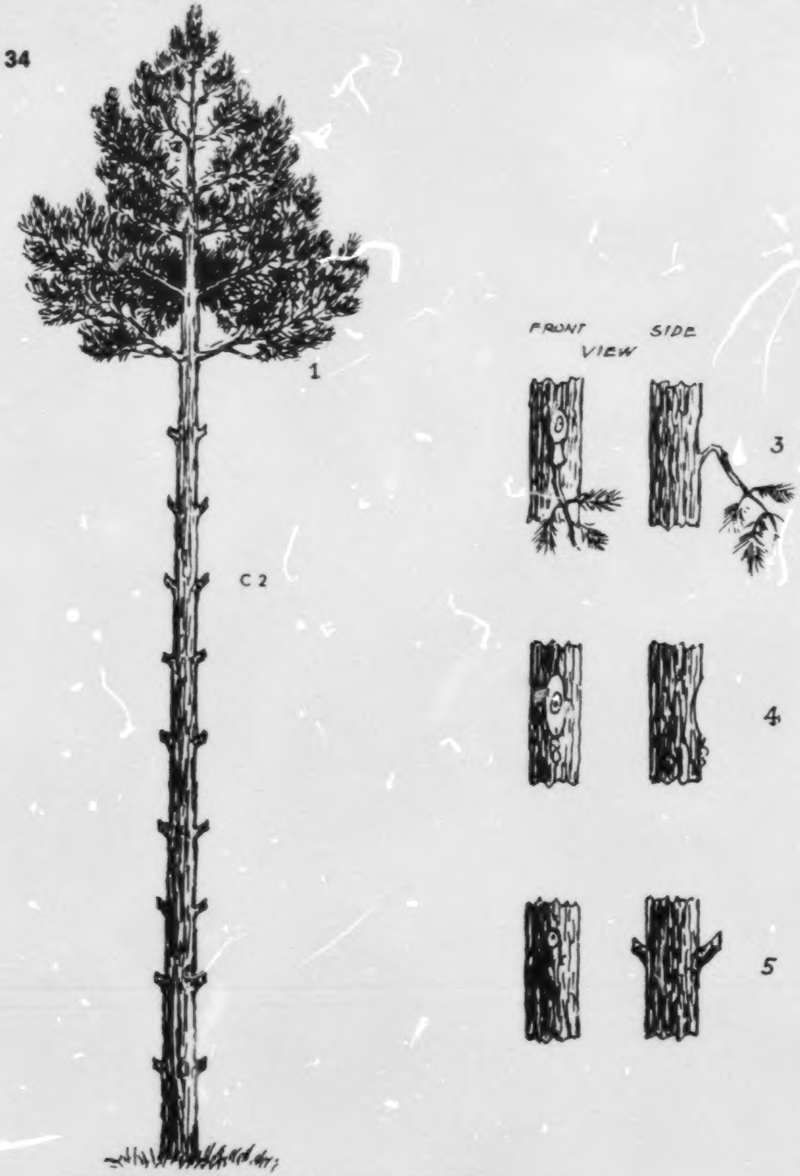


ILLUSTRATION OF A POOR PRUNING JOB

1. Tree pruned too high.
2. Branches not cut flush with stem.
3. Tearing and injury of bark by improper cut.
4. Too deep a wound.
5. Dead stubs lower portion of stem not removed.

NOTE: In both of these examples the live crown represented two-thirds of the total height of the tree before pruning.

JULY 59
JENS V. SIVERS.

Even-age forest, red pine

brush, measures should be taken to control them. On heavier soils, cultivation may be practical. If heavy brush soils, cultivation may be practical. If heavy brush comes in after planting, it may be necessary to keep it cut back until the plantation is established. Selective herbicides have been developed and may be used to control unwanted vegetation in a plantation. Because of the importance of using the right herbicide in the right amount at the right time, it is recommended that the local forester be contacted. His experience and knowledge in this field can prevent serious losses due to improper chemical use and application.

Survival

After the trees have been planted for one or two years, a survival count should be made. This is done by walking a row of the plantation and sampling ten trees to determine those living and those dead. Repeating this procedure at random throughout the plantation will give an overall survival percentage. If your survival falls below 70%, the dead trees should be replaced the following spring.

Summary

Intermediate cuttings are partial cuttings in immature forests only. There are six intermediate cuttings: cleaning, improvement, liberation, thinning, pruning, and salvage. The purpose of intermediate cuttings is to improve the composition, growth, quality, and total production of the forest

A garden of carrots illustrates the principles involved in management of an even-aged forest. When the carrots are very small, cleaning operations remove the weeds which threaten the crop. An improvement operation removes those with damaged tips and defective ones when they can be detected. Next, a liberation is made by removing the overtopping weeds which are hindering the development and were missed in the cleaning operations. Now, thinning is required to reduce the density and provide more growing room; the first thinning may not yield usable products, but each thinning provides more food on the table. The need for a salvage arises as an insect or disease destroys some of the "crowns". When maturity is reached, all of the carrots must be removed (clear cut) or they will rot. If removed too early, maximum yields are not realized.

Management of an all-aged forest is similar to a farmer's managment of his dairy herd. The barn contains cows of various ages that reproduce and provide for replacement as does one acre of mixed hardwood forest. The culling of the herd to retain only the best producers is similar to an improvement cutting in the forest. The most profitable producers are held until old age, injury, or disease reduce production just as the selection system removes the economically mature trees.

Methods that Promote Reproduction

"What trees should I cut?", is a simple question with a complicated answer. A forest may be classified as immature or mature. There are certain cutting practices dictated by nature which are employed in management to achieve maximum growth from the forest to work contrary to nature spells defeat. Selecting trees for logging of merchantable products involves major decisions by the owner.

The selection of the right trees and cutting practice will result in a high production from the forest area and will provide for harvests in the future. Improper cutting will reduce future harvests, thereby reducing the financial return to the owner.

The proper forest management cutting practices to be used on different types of timber have been determined by scientific means to provide (1) the maximum return from the forest over a period of years and (2) adequate regeneration of the area.

Mature forests

Even-aged forests such as pure stands of aspen (popple), jack pine, black spruce, oak, and tamarack, are composed of intolerant species which grow up together reaching for sunlight. When even-aged forests are mature, all of the trees should be cut since they are essentially of the same age. This practice is called clear cutting.

Even aged forests

The even-aged forest, as aspen or jack pine, results from intolerant species which cannot live in shade and, therefore, grow up together reaching for sunlight. Visualize one acre of an aspen forest. As the trees become larger and require more growing room, many are "crowded out" because of less favorable start, inherited factors of slower growth, injuries, root competition, insects, or diseases. As the individual trees throughout this forest fall slightly behind and receive less and less sunlight they gradually decline in growth and, because they are intolerant, start to die out. This is a continual process as the forest grows; from 12,000 seedlings per acre, only 100 trees may be alive in 50 years.

It becomes apparent that the trees in an even-aged forest grow up together and mature at the same time. Therefore, all of the trees must be cut at one time when maturity is reached. This practice is called clear cutting.

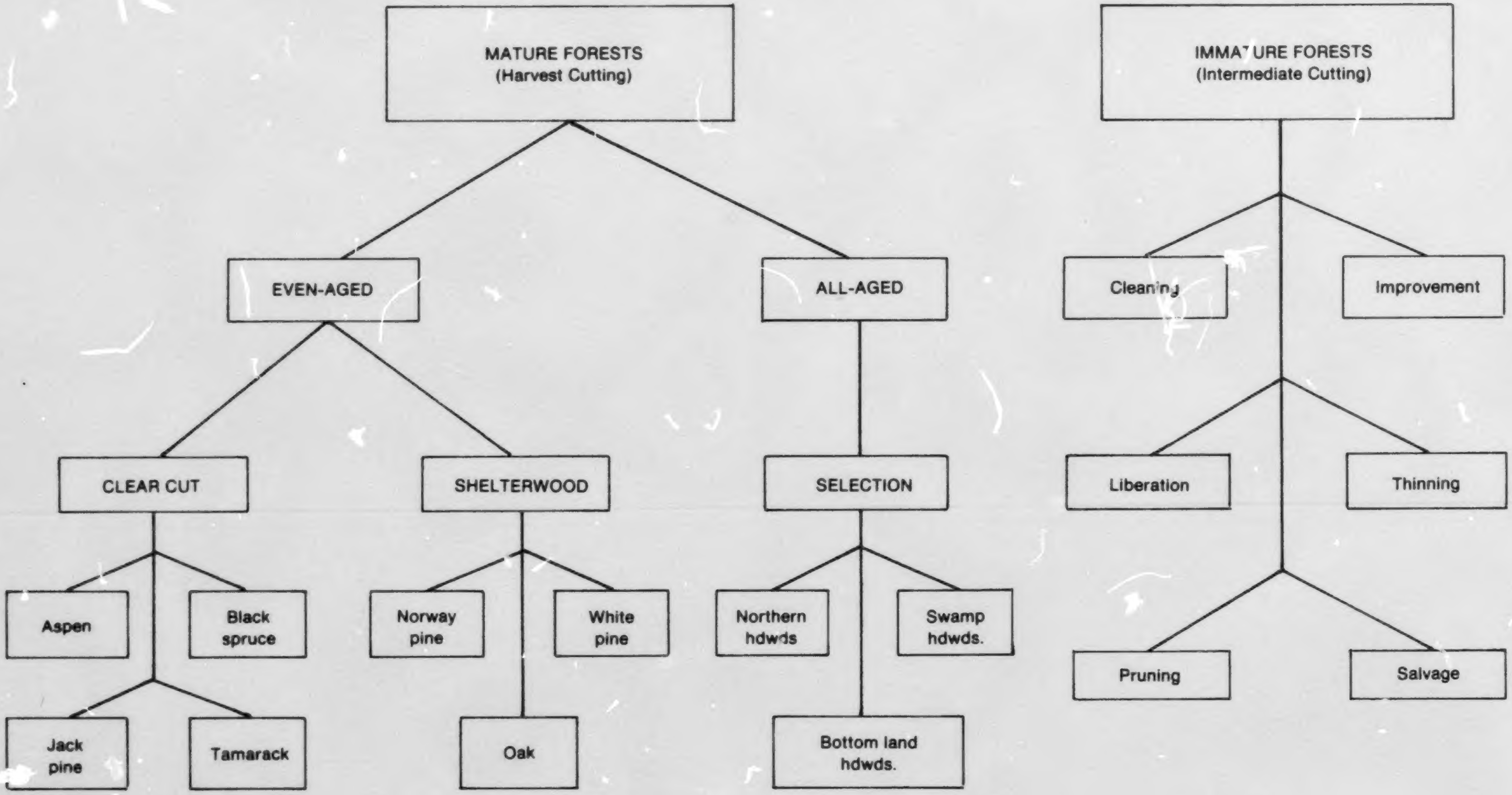
Clear cutting is the recognized and recommended management practice for aspen (Popple), jack pine, black spruce, tamarack, and even-aged balsam forests. When does the even-aged forest mature and at what age should it be cut?

The answer to this question depends upon the requirements of that species for type of soil, nutrients, ground moisture, etc. Aspen in one part of the forest will mature in 60 years, whereas, in another part of the forest it cannot be held over 35 years. The forester determines maturity by obtaining the age of the trees and measuring the height; the inter relation of height to age indicates the suitability of the growth factors to species on that specific area and the proper rotation age (see Site Curve, Figure 31).

All-Aged Forests

Mature all-aged forests are cut by one of the three methods: selection system, clear cutting method and shelter wood method.

Figure 35
FOREST MANAGEMENT
Cutting Practices of Major Types of Forests


MATURE FORESTS
(Harvest Cutting)
EVEN-AGED
ALL-AGED
CLEAR CUT
SHELTERWOOD
SELECTION
Aspen
Black spruce
Jack pine
Tamarack
Norway pine
White pine
Oak
Northern hdwds
Swamp hdwds.
Bottom land hdwds.
IMMATURE FORESTS
(Intermediate Cutting)
Cleaning
Improvement
Liberation
Thinning
Pruning
Salvage

Selection System

The selection system is the management practice for mature all-aged forests. Economically and biologically mature individual trees are marked for cutting. The selection system is recommended for the management of northern hardwoods, swamp hardwoods and bottomland hardwoods.

The trees to select for cutting are the poor potential producers that will increase only slightly in future value, or which may decrease in value, if allowed to remain. Trees such as the deformed, diseased, slow growing, poor merchantable height, low valued species, those with open crowns with many dead branches, and the defective trees should be selected for cutting.

How many trees should be removed? It is difficult to answer this question. The amount to remove depends upon the present condition of the timber and the cutting cycle-when the next cut will be made. It is recommended that technical advice be obtained in determining the amount of timber to cut. Over cutting can materially reduce the productivity of the woodland. Individual trees that will increase only slightly in value before the next cut is made should be removed.

How often should the mixed hardwood forest be cut? Hardwood forests can be cut annually if the owner so desires. However, the volume that can be removed in an annual cut is rather small; therefore, it is a common practice to cut a given area every five or not more than 10 years. If the amount cut is equal to or less than the periodic growth, the cutting can continue indefinitely.

A mature all-aged forest is like money in the bank. The interest (growth) can be taken every year or periodically without hurting the investment (the forest). If the principal (growing stock)is reduced, the earnings (harvest) are also reduced.

Can you detect any similarity between this cutting practice and the farmer who culls and improves his dairy herd by milk-testing and artificial insemination?

A diameter limit cutting, in lieu of marking the trees to be cut, is often used to harvest the forest; for example, all trees above the given stump diameter (as 18 inches) are removed. It is apparent the diameter limit cut removed the larger trees from the forest but does not remove the economically mature smaller trees. Although this cutting practice offers an improvement over clear cutting of all-age forests, it does not offer the refinements obtainable in individual tree selection by marking.

Immature All-Aged Forests

Fully stocked immature all-aged stands, such as pole size mixed northern hardwoods, can be improved in quality and growth by judicious intermediate cuttings.

1. The poor growing, defective, low valued, poor potential trees should be removed to favor the better trees. The cutting should not be too heavy and can be conducted every 10 years to maintain a vigorous forest.

2. Clear cutting of shade intolerant species which grow in even-aged stands: e.g., aspen, jack pine, black spruce, and tamarack forests.

Rotation age, the age at which an even-aged forest is mature, is extremely variable and depends upon the soil-type, moisture, and nutrients. Rotation age is determined by measuring age and height of the trees.

3. The shelterwood system: white pine, red pine or oak forests, although essentially even-aged, cannot be clear cut at maturity because they may not reproduce adequately. Clear cutting these types frequently results in the invasion and capture of the area by brush. Therefore, the shelterwood system is employed as a harvest cutting practice for white and red pine and oak forests.

The shelterwood system consists of clear cutting the stand of timber over a period of years. The first cut at or near maturity removes up to one-half of the trees and opens the stand gradually. Sunlight reaching the forest floor decomposes the leaf or needle litter and increases the temperature to assist the germination of the seed. The second cut about five years later may clear cut the residual volume if adequate reproduction is established, or may be a second partial cut. Once reproduction is adequate, the remaining trees are removed. The shelterwood system has been used for centuries in the management of European forests where steep slopes demand a continuous forest cover to prevent severe erosion.

Other Management Systems

Variations of the basic systems of clear cutting, selection, and shelterwood are often used by foresters to achieve special management objectives. Clear cutting in groups is used to regenerate species like yellow birch which are not as tolerant as some of the other species in an all-aged forest. Clear cutting in strips may be employed in tamarack stands to provide added seed sources in the cut areas and prevent an undesirable change in the water table. The seed tree system, a variation of shelterwood, leaves scattered wind-firm dominant trees as a seed source until the cut area is regenerated.

Summary

Timber Types	**Cutting for Natural Regeneration**
Aspen	Clearcut
Spruce-Balsam	Selection or Clearcut
Tamarack	Clearcut in strips or patches
Black Spruce	Clearcut in blocks or strips
Jack Pine	Clearcut (may leave seed trees)
Norway & White Pine	Shelterwood or Selection
Northern Hardwoods	Selection or Clearcut
Bottomland Hardwoods	Shelterwood or Clearcut

Shelterwood system of clear cutting over a period of years for essentially even-aged forests difficult to reproduce as white pine, red pine, and oak.

Other management practices to achieve specialized objectives are variations of the above three basic methods.

Species Management

Mature red pine, white pine, and oak forests are managed by the shelterwood system when they reach approximately 100 years of age. These mature stands are clear cut over a 10 to 15 year period with the best trees left for last to re-seed the area cut.

Immature, even-aged forests including the red pine, white pine, and oak types can be improved in quality and quantity production by favoring the largest, tallest, and healthiest trees and removing the others in light 10 year periodic cuts. The best "crop trees" should be thinned to a spacing of approximately one-fourth the height of the timber.

Mature, all-aged hardwood forests are cut by the individual tree selection system. The large, and generally slower growing trees, are removed and, in addition, the economically mature trees with poor potential for increased value.

Immature, all-aged hardwood forests are cut to remove the trees with poor potential: poor form, slow growing, defective, low valued species, and poor merchantable height.

It is apparent the most money can be obtained at any given moment from a woodland by selling all of the saleable timber. A farmer by the same process of liquidation can sell his entire dairy herd and obtain the most money. However, neither the dairy farmer nor the woodland owner would make the most money over a period of years if the potential of the cows or the trees were not fully realized.

High taxes make good management a necessity to stay in business. Just how profitable forestry can be depends to a great extent upon the cutting practice used by the owner.

Major Wisconsin Timber Types

Northern Hardwoods

The principal species of this type are sugar maple, red maple, yellow birch, eastern hemlock, basswood and American elm. Frequently associated with these species are white ash, balsam fir, white pine, white spruce, aspen, paper birch and ironwood. Northern red oak, black cherry and rock elm are important associates in some localities.

Most of the northern hardwood stands in Wisconsin are young growth arising after commercial clearcutting of the virgin timber. They are usually well stocked with saplings and poles and have a varying amount of residual old growth, sawtimber-size trees that were unmerchantable at the time of the first cut. Stand quality is highly variable.

The objectives of management are to grow trees to large sawtimber size, to produce quality products and to maintain a diversity of species with high individual stem quality. Tree quality must be emphasized in management because of consumer needs and the great influence on economic returns.

When the above management objectives are fully attained, the stand will have good growth, yield high-quality products and have continuous seedling reproduction. Under this system of sustained yield forest management, a stand of high-quality trees is developed and maintained by removing trees from the entire range of size classes through a continuing series of cuts made at approximately 10-year intervals.

Most hardwood stands contain large numbers of defective and poorly formed trees in addition to those of unwanted species. In selecting trees for removal from northern hardwood stands, concentrate on removing the trees with the poorest silvicultural and economic characteristics and leave the best ones.

When deciding which trees to select for cutting and which to leave, the following items should be considered in the order listed:

1. *Risk*—Any tree that will not live and grow until the next cut should be removed.

2. *Cull*—Trees that are highly defective and will not increase in value during the next cutting cycle should be removed.

3. *Form and Quality*—Crooked and leaning trees, those with a short clear length and those with a log-grade bole should be considered next for removal.

4. *Species*—Difference between tree species should be next in consideration. Yellow birch, basswood and sugar maple should be favored.

5. *Economic Maturity*—Trees that have reached beyond the 24" d.b.h. range do not pay their way in comparison to smaller trees.

6. *Crown Position*—Tree crowns that interfere with full development of other trees of higher potential should be considered for removal.

It may take a number of cyclic cuts in an unregulated forest before the structure and quality necessary for high-level production are developed. After a stand is regulated, application of the general rules listed should permit the maintenance of suitable conditions for optimum growth in volume and quality.

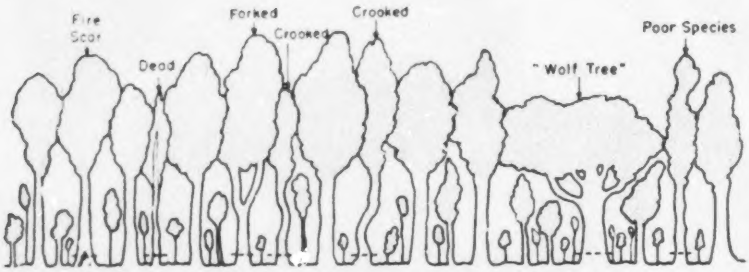
Oak-Hickory

The principal species of this type are northern red oak, white oak and minor species such as hickory, maple, basswood, white ash and walnut on the better sites. Black oak on the poorer, drier sites make up most of the forest with an occasional red oak, white oak, hickory and other associated species. The present stands strongly reflect the land-use history of each area. The present composition of these stands depends more on the past treatment of the area than on site quality. So the present forest type is not necessarily a dependable guide to the species best suited to the site.

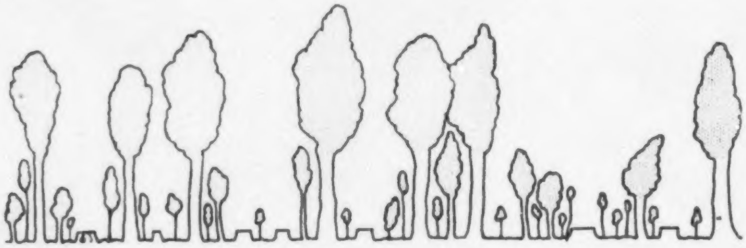
Objectives of management are to grow the most high-quality sawtimber the site can produce in the shortest possible time by controlling the density and composition of the growing stock; and to harvest mature stands in such a way as to regenerate the most desirable species in number adequate for the site.

Management principles include managing the species as even-aged stands. Two distinct phases are recognized during the rotation period: intermediate cutting and reproduction cutting. Intermediate cuts may have several

Figure 36
FOREST MANAGEMENT
Intermediate Cuttings



BEFORE IMPROVEMENT CUTTING



AFTER IMPROVEMENT CUTTING

A hardwood forest illustrating the type of poor growing stock removed in an improvement cut. The residual forest is composed of the healthier, faster growing trees in the future, as their potential drops off, they too will be removed.

The growth added to the trunks of these pruned trees will produce high quality, knotfree lumber in the future.

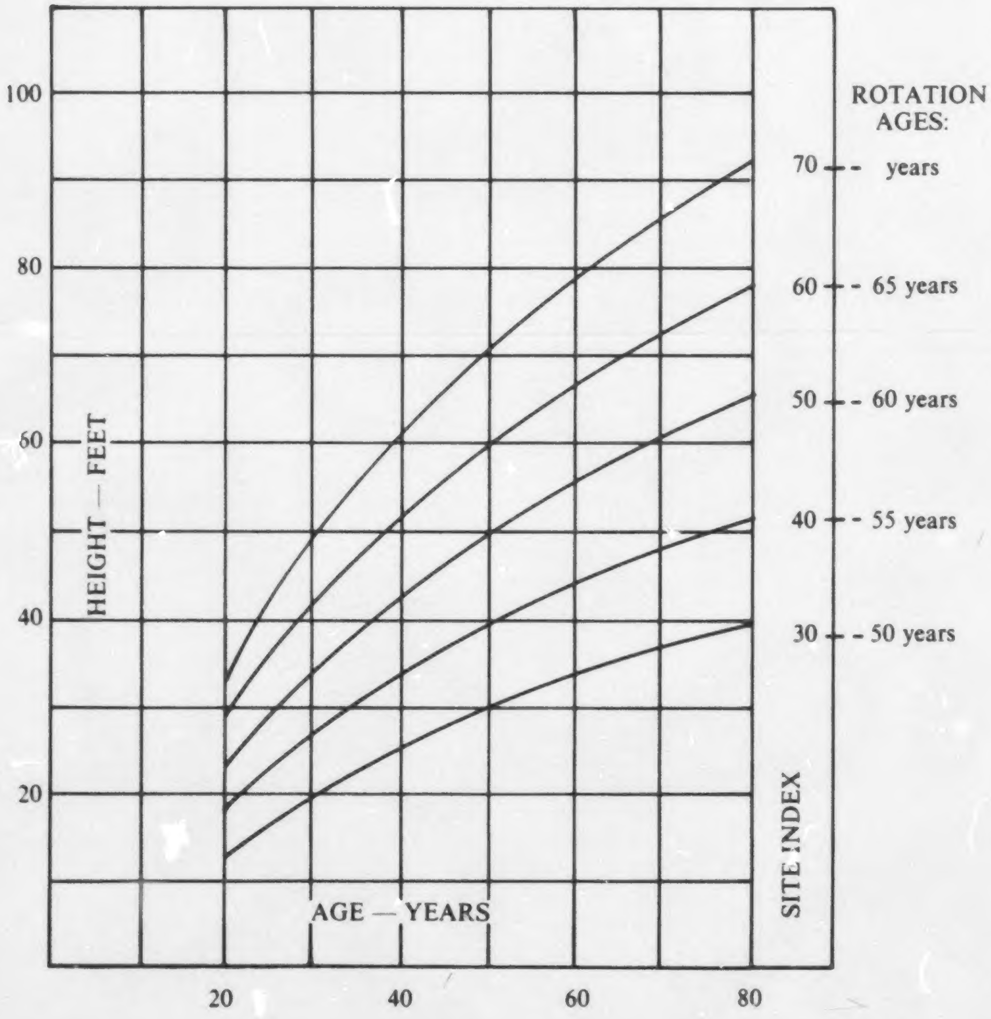
The growth of the pine can be increased by a liberation cut. The removal of the hardwood will release the pine.

Figure 37
SITE INDEX CURVES

ROTATION AGE OF JACK PINE ON DIFFERENT SITES

The height at a given age reflects the suitability of that particular site to the jack pine and is used to predict maturity. Premature harvest or allowing the species to become over-mature results in reduced net yields per acre.

JACK PINE



objectives such as improving species composition, releasing desirable trees and controlling spacing. Reproduction cuttings are made only once during a rotation and only in mature stands.

Intermediate cuttings should maintain adequate density in the size class that represents the "main stand." In deciding when and how to make an intermediate cut, decide first on the stand that should be left, then cut to achieve it. For oaks, intermediate cuts or thinnings should be stopped at about 60-70 years on medium sites and earlier on poorer sites.

Reproduction cuttings should be clear cuttings to insure regeneration. At the time of harvest cut, all trees larger than 2 inches d.b.h. should be removed or killed. This should be done as soon after logging as possible.

Successful application of the above principles depends upon the judgement of the person managing the stand. Successful management and regeneration of the oak-hickory type requires adherence to the following rules:

1. All cutting units should be of similar site and stand conditions.
2. On each unit, tailor the cut to the needs of the stand.
3. During intermediate cuts:
   a. Do not thin understocked stands.
   b. Keep the stocking up to the minimum recommended for this type.
   c. Keep spacing in mind. Residual trees should be distributed as evenly as possible over the area.
4. During regeneration cuts:
   a. Do not leave pole-size trees or large saplings in clearcut openings.
   b. Space areas chosed for regeneration cuts far enough apart to permit creating one or more additional openings between them during some future cut.
   c. Openings should not total more than 10 to 15 percent of the area of any forest unit so as to provide for sustained production.

Aspen-Paper Birch

The principal species of this type are quaking aspen and paper birch. Bigtooth aspen occurs on the coarser-textured soils, but is considered along with quaking aspen as one species.

Aspen is intolerant to shade and grows generally in even-aged stands. Most stands originate from seed and suckers on burned-over areas. Aspen suckering from the roots is profuse after cutting. Suckers produced on clear-cut areas generally provide adequate reproduction, except where brush is heavy. Suckers grow rapidly the first two or three years and then slow down and maintain a fairly steady growth rate.

Paper birch has a greater degree of tolerance than aspen, but is still classed as intolerant. Like aspen, paper birch occurs in even-aged stands which started on burned-over areas, chiefly from seed. It is a prolific seeder and sprouts readily from the stump but does not produce root suckers.

Either aspen or paper birch may occur in pure stands or in varying degrees of mixture with each other. When mixed, the paper birch is generally the smaller due to its slower initial growth and greater tolerance.

Objectives of even-aged management are to clear cut at rotation age (based on site capacity) where this type is to be managed for continuous aspen production and, when conversion is practical, partial cutting and stand improvement practices are recommended.

Recommended harvest ages for indicated sites are:

Site Description	**Harvest Age**
Poor	35 or less or when merchantable for pulpwood
Medium	45 (40-50)
Good	50 (45-55)
Very good	60 (55-65)

Red Pine

The principal species is red pine with the remainder consisting of one or more species such as jack pine white pine or a mixture of many species. It can be associated with minor species such as red oak, paper birch, aspen, spruce or fir. Red pine is usually best adapted to sands, gravels and dry sandy loam sites. It is generally temporary to be succeeded by a more tolerant species, usually white pine.

Objectives of management are to maintain red pine or red pine sites, produce maximum yields from present stands and to expand the acreage of red pine type on sites suitable for red pine.

Management principles include managing the species as even-aged stands, with intermediate cuts every 10 years, shelterwood regeneration and harvest cuts at rotation age. Management of red pine stands should begin at the earliest possible age.

From age 0-20, the young trees must be released from competition to permit maximum growth. Dominant and codominant trees should be spaced 8 feet by 8 feet.

From age 20-40, it is essential to give red pine a complete release. The stand can be cut from below, taking into consideration stand spacing and the growth of dominant and codominant trees. Pruning of 100-150 crop trees per acre should be carried out.

From age 40-120, selection of 50 final crop trees must be done. Cutting should remove trees in the following priority until desirable stocking is achieved: cull trees, defective trees, overmature trees, sound low-quality trees and mature trees.

From age 120-140, the primary management objective is to regenerate the stand by shelterwood cuttings. If reproduction is not present, scarifying the area before seedfall in a good seed year is necessary. If natural reproduction does not become established, artificial methods should be employed.

Jack Pine

The principal species is jack pine. It usually occurs in pure stand or open mixtures with aspen or oak on the dry, sandy soils. On heavier soils, it is mixed with oak, red pine or aspen.

Objectives of management are to grow the highest value products that the site will produce in the shortest time and to regenerate the stand in the harvest cutting to a fully stocked mixture of red pine and jack pine.

Management principles include managing the species as even-aged stands with intermediate cuts at 10-year intervals and harvest cutting at rotation age.

From age 10-20, noncommercial thinnings to achieve an 8 ft. by 8 ft. spacing.

From age 30-40, an improvement cut from below yielding pulpwood-size stems.

At age 50, harvest the stand if only a pulpwood market is available. For regeneration, scarify to expose mineral soil and scatter come-bearing slash.

Recommended harvest ages for indicated sites are:

Site Description	Pulpwood Harvest Age
Poor	50
Medium	50
Good	50

Increasing the Growth and Quality of Native Hardwood Trees

In hardwood forest management the major goal is to produce the highest value timber in the shortest amount of time. To achieve this goal, management efforts need to be directed initially to the individual trees with the highest economic potential.

Woodland owners, who have existing stands of hardwood trees such as black walnut, black cherry, the maples, birches, oaks, hickories and ashes which normally make up our hardwood forests, should spend a few days each year working in the woods doing what they can do to accelerate the growth and improve the quality of individual trees. A little effort applied today to hardwood trees can make it possible to cash in on timber crops way ahead of Mother Nature's normal schedule.

Selecting Crop Trees

The first thing to do is to walk through the woods and select the trees to be favored in an improvement program. The crop trees should be from species that have been popular through the years in the production of fine cabinets, gunstocks, paneling and furniture. It would be advisable to select the trees with the assistance of a professional forester to insure proper identification. The trees should be marked or perhaps even numbered by use of paint, or a twine and tag system. Do not nail tags to the trees or make deep blaze marks in the bark with an axe.

Thin, Release and Fertilize

The crown area immediately around crop trees should be thinned to permit expansion of the top of the tree. This step will permit increased leaf development and provide more sunlight for the leaves. The leaves use the sunlight to produce much of the food needed by the tree.

The root area under the crown of the tree should be released of all excessive competition for nutrients and moisture. All vines, brush, weeds and small trees should be kept at a minimum in the root area. They can be controlled by chemicals or by removal through cutting.

On sites that are deficient of desirable quantities of available nitrogen, fertilizer may be needed. Many upland timber sites are in need of fertilizer treatments. Nitrogen is an extremely important element in the growth and development of trees. Maximum growth cannot be obtained unless sufficient quantities are available for the tree to use. Ammonium nitrate (33% available nitrogen) can be applied in pellet form around each tree to increase the supply of available nitrogen. A soil test is recommended if there is any question about the need for fertilizer.

When to Thin and Release

Thinning and releasing can be done anytime of the year. However, it is easier to work in the woods during the winter months when the leaves are off the trees. The winter months are normally best for those woodland owners in the farming business because the row crops will have already been harvested.

How and When to Fertilize

The ammonium nitrate pellets can be spread on the ground in a circle around the trunk of the tree according to the manufacturers recommendations. Forest research agencies have suggested that the application be made in the spring of the year. However, fertilizer dealers feel that application can be made in the winter once the average daily temperature drops below 70 degrees. Research has indicated that responses to the fertilizer application do not normally occur until the second growing season. One fertilizer application should last for 8 to 10 years.

Improve Quality at Same Time

On larger trees, cutting vines may be the only way to directly affect quality. However, on the smaller trees, 2 inches to 8 inches D.B.H., the quality of the logs produces can be improved by log length pruning. Lower limbs should be pruned close to trunk being careful not to leave a stub. The limbs should be pruned before they become larger than 1 to 1 1/2 inches. Care should be taken not to prune more than one-third the live crown in any one growing season. Repeat the pruning through the years until 17 feet of clear length is achieved. Seventeen feet will produce a 16-foot, clear length butt logs.

Cost

The cost of thinning and releasing work depends upon how much work is needed and how many crop trees there are per acre. An estimate of the cost could be made by a forester prior to actually starting the work.

The cost of fertilizer application can more accurately be calculated once the number and size of trees is known. Ammonium nitrate pellets will cost less than 5 cents per pound in most areas. Application is easy and requires very little time.

The cost of thinning, releasing, pruning and fertilizing will be more than compensated for by the increased growth and quality, and the reduction in the time required to produce a marketable tree.

Maturity and Forest Age Factors

Even-aged forests as mature white pine, red pine, and oak are difficult to regenerate and are managed by the shelterwood system. The shelterwood system is the clear cutting of the forest in two or three stages over 10 to 15 years when the timber is over 100 years old. This is accomplished by removing approximately one-fourth to one-half of the trees in the first cut, and all of the merchantable trees in the fineal cut. The most vigorous, well formed, wind firm individuals are left until the final cut.

Young immature white pine, red pine, and oak forests are managed the same as other immature even-aged forests.

Immature Even-Aged Forests

Fully stocked young stands can be improved by intermediate partial cuttings: thinning, liberation, improvement, etc. Partial cuttings in understocked stands are not recommended. Assuming a fully stocked forest of one of the types indicated above, what trees should be cut, how often, and how many?

Light cuttings every five to ten years should be made to favor and benefit the tallest, healthiest and largest final "crop trees" in the forest.

Select for cutting (1) the poor growing, defective, forked, excessively limby, small crowned, low valued species and (2) the trees competing for crown space with the "crop trees." Note the "best" trees are left and the "poorest" are cut.

How heavy should the cut be made? Foresters employ various means to determine the proper degree of cutting. An easily understood rule of thumb is to thin the stand to a spacing of approximately one-fourth of the total height of the tree, e.g., jack pine 40 feet tall would be thinned to approximately (one-fourth times 40) 10 feet apart. The residual forest of the best trees would be spaced 10 feet apart and the others would be removed. This generalization applies only to immature even-aged forests and not to all-aged forests.

Mature All-Aged Forests

All-aged forests, illustrated by northern hardwoods, swamp hardwoods, and bottomland hardwoods, are composed of tolerant species of trees that reproduce and grow in the shade. This forest, if undisturbed by grazing, is composed of trees of various species, sizes and ages. All-aged forests are considered mature when the forest contains large mature sawtimber trees. It is evident from the foregoing that this mature forest also contains numerous immature trees of various sizes.

All-Aged Forests-Selection System

The all-aged type of forest, such as mixed hardwood, is composed of shade tolerant species which can survive from moderate to dense shade. Visualize one acre of unpastured hardwood forest of maple, basswood, elm, ash, etc. This acre of all-aged forest is composed of trees of varying sizes and ages from small seedlings to mature timber. The tolerant trees growing in the shade will grow more slowly than those receiving full sunlight, but the majority continue to survive. When a larger dominant tree is cut or dies, a tree from the understory is in position to take its place.

Economic Aspect of Intensive Management

The maintenance practices are aimed at a period of 3-5 years after establishment. Beyond this period, the management requirements shift somewhat from those steps that were aimed at insuring survival and protection from fire, insects, diseases and competing vegetation. The guard against fire, insects and disease must be maintained, but plans should be formulated for future thinnings, and other cultural practices that are designed to keep your plantation growing as rapidly as possible. Consultation with a forester is suggested when the size or age of a plantation is such that management practices should be prescribed. These recommendations will vary depending upon species, soil capabilities, intent of the owner and availability of markets for initial material removed.

A well-managed pine plantation can produce over a cord per acre per year during the first 40 years after planting, and red and white pine plantations can produce at least 700 board feet per acre per year from age 40 to the time of final harvest. Without management these growth rates cannot be attained. A 15-inch diameter pine can be grown in 75 years or 165 years depending upon the management techniques used.

Record Keeping and Accounting

Record keeping and accounting are a necessary part of the forest woodland operation. Records need not be complicated but should provide the necessary employment, tax operational expenses, etc., to satisfy tax authorities and provide a basis for a profit-loss statement on an annual basis. Good record keeping often makes a difference between success and failure.

Complete records should: (1) Provide information for income tax reports (2) Provide accurate records of production costs (3) Give a summary of invested capital and net worth (4) Provide written summarization that will permit better management planning. In the appendix are several record keeping forms which may be used as guides in woodland management.

Financial Assistance

Operations other than commercial thinnings, such as pruning, release and noncommercial thinnings, require a cash outlay. Because of the long-term nature of the timber crop, the risks involved, and because of the public benefits derived from plantations in the form of soil and watershed protection, wildlife habitat, and beautification of the landscape, the federal Agricultural Conservation Program may offer cost-sharing assistance to landowners who are willing to carry out improvement measures in their plantations. For further information on this assistance, contact your county Agricultural Stabilization and Conservation Service office or your local Department of Natural Resources forester.

Suggested Learning Activities

Classroom

1. Invite forestry personnel to give a talk on forest improvement.
2. Study school forest plot records for examples of the need for improvement.
3. Make a list of desirable and undesirable species found on the school forest or in your county. List reasons why they are desirable or undersirable.
4. List the characteristics of a good tree for forest production.
5. Visual aids and films.

Field

1. Visit nearby forest areas where improvement cutting, thinning, or pruning are demonstrated.
2. Thumbtack numbers to all the trees on a 1/5 or 1/10-acre plot or left in an improvement or thinning cut. Check with a forester's opinion.
3. Take pictures of stands before and after an improvement cut. Use same camera location.
4. Set up a special plot and prune selected trees.

CHAPTER EIGHT

HARVESTING, MARKETING, AND PROCESSING CUT FOREST PRODUCTS

Planning The Harvest

Sell your forest products for a profit. It is the reward for good forest management. Before you can make a profitable sale, you must find the most profitable market either for sale of the trees on the stump or the converted products.

A little effort on your part can uncover numerous outlets for your forest products.

- Ask your neighbor; they may have just made a sale.
- Ask your local Department of Natural Resources forester for up-to-date market information.
- Look for advertisements wanting to buy forest products in your local newspaper.
- You can run your advertisement in a local paper, forest products marketing bulletin or other trade publication.
- Write several wood-using industries near you requesting their specifications and prices. Often times they will have their buyer call if requested.

Be sure a market exists before you harvest your timber unless you intend to use it all for farm or home construction.

Be sure you have the specifications of the buyer if you are going to sell converted products. All profit may be lost if many logs, posts, poles or pilings are rejected by the buyer.

There are several ways to sell your timber crop. The two most common methods are:

1. Stumpage or as standing timber.
   a. lump sum
   b. thousand board feet, cord or cubic foot
   c. by the tree
2. As converted products after you or a contractor you hired cut the trees into products.

There are advantages and disadvantages to each method. Often, methods of selling timber can be combined and modified to suit the seller's situation and desires.

The owner is in a favorable position if he plans to harvest his own timber. With the help of a forester, a long range plan can be developed that will result in increased returns as well as a continually improving stand of timber. In other words, the owner can practice timber stand improvement, often under a cost sharing government incentive program.

Another advantage for the owner is the fact that he can earn his own wages during slack time from his regular occupation. By cutting products as markets become available, he receives a higher price.

The commercial operator is skilled in harvesting wood products and generally commands a better market outlet due to continuous contact with buyers. He also understands market trends and can harvest a timber stand to best advantage.

Intelligent selling is based on knowledge of what one has to sell, both as to amount and quality. It requires thought, care, and experience. Advice from your local Department of Natural Resources, or consulting forester should be sought until you are confident you can go it alone.

Sales Contracts

A timber sale contract is an agreement, usually written, signed by both parties to the agreement, prepared to cover the sale of either standing timber or timber products.

A contract serves as a bond of good faith on the part of both parties involved to transact business in a manner satisfactory to both and insure against disputes and dissatisfactions.

A timber sale contract will protect the seller by assuring him that a known volume and quality of timber will be involved at a predetermined price, subject to recognized restrictions or regulations covering the harvesting and measuring methods.

A contract will protect the purchaser as well in allowing him to base plans for harvesting and utilization on definite quantities and sound economics. A sample copy of a timber sale contract is included in the Appendix which can be modified to satisfy local situations.

Sale of Cut Logs or Other Timber Products

Many woodland owner's are aware that greater financial returns from their woods are accrued by doing their own harvesting. Products produced such as logs, pulpwood, posts, tie cuts, barrel staves, or fuelwood are sold to local suppliers or to distant mills.

Before harvesting products for sale, it should be clearly determined that the following provisions are covered:

1. Definite specifications of acceptable products.
2. Quantities of various grades that will be accepted.
3. Unit price for each product.
4. Total sum involved and method of payment.
5. Time limits to prevent spoilage.
6. Method of measuring and grading.
7. Time and method of payment for products.

It is desirable to execute a written contract between seller and buyer to protect both. Undertaking a harvesting program without knowing market requirements usually turns into an unprofitable venture to the owner and poor utilization of the products produced.

General Rules

Deal with reliable jobbers, mill operators and wood-

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using concerns. They will agree to enter into a written contract with you. Operators that shy away from contracts should be avoided to prevent loss of your money and timber.

Avoid selling timber on a "lump sum basis" unless a forester recommends such sale because of species or other valid reasons.

Enlist the assistance of a forester in drawing up any timber sale contract to insure all necessary points are covered in writing. If there are unusual legal angles involved, the assistance of an attorney should be sought.

Any sale of standing timber should be based on the per unit or stumpage basis which allows for a total payment tied to the volume of timber involved. Contracts on a gross or acreage basis allowing for payment on a fixed price regardless of the amount of timber involved and are *not* recommended. See "Timber Sale Agreement," in Appendix.

Harvesting Woodland Products

Harvesting is important to the timber owner. The quality and quantity of the timber is mainly a result of forest management. Any type of harvesting should provide for eventual reproduction of the stand.

Timber Cutting Notices

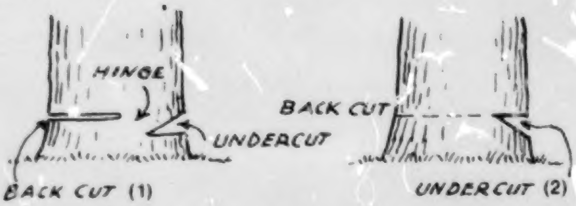
Before cutting forest products to sell, it is necessary that a notice of harvesting be made to the county clerk. A section of the Wisconsin Statues states that a notice in the English language giving his name and post-office address, and listing all the lands upon which such cutting is to be done, designating the same by each 40 acre government sub-division or fraction thereof with the proper, section, town, and range, by registered letter addressed to the county clerk of each county in which the land is located. Timber cutting notices can be obtained from the county clerks office.

Proper Cutting of Trees

The following precaution and practices will prevent excessive logging damage to remaining trees.

1. Don't fell trees on young growth, pile the slash in areas that have no reproduction
2. Avoid felling trees so that no damage occurs to remaining trees.

Figure 38



Two types of undercuts
(1) The strip of uncut wood acts as a hinge when tree falls toward undercut.
(2) This undercut results in a log of full length.

Broken branches and skinned stems are often the direct cause of later defects. When cutting the tree, determine the best direction to fall, considering lean, wind direction, possible breakage, and damage to saplings or reproduction. Make the undercut as close to the ground as possible, usually under 12 inches on a sawlog, or under 8 inches on a pulpwood tree.

Cutting the Logs

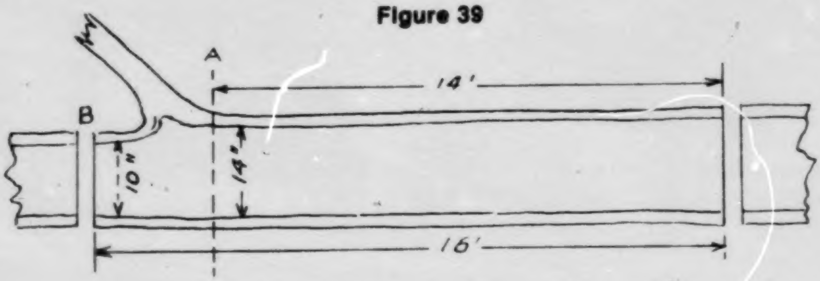
Producing logs for home use or the commercial market demands more skill than felling the tree and cutting the logs to length. The appearance and quality of logs produced determines what a buyer will pay. For home use it is important to produce logs which will give the greatest yield of usable material.

Bucking is sawing felled trees into shorter cuts. How a tree is bucked depends on several factors; the minimum log size that is marketable under existing specifications of available markets or log grading rules and the amount of defect in the tree.

Before any forest landowner cuts logs, there are several important points to consider:

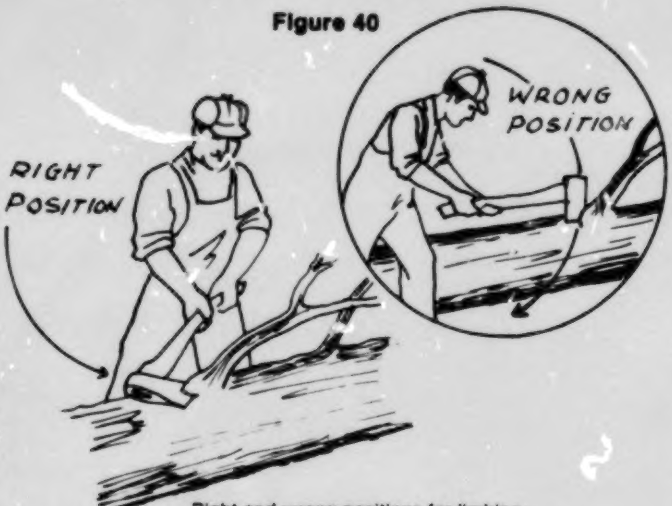
1. Follow the buyer's specifications carefully. Failure to do so may result in rejected logs, or a loss in footage.
2. Keep your logs straight, avoiding crooks and sweep.
3. Cut the logs for highest quality and group defects when possible.
4. Leave a trim allowance on all logs in accordance with the buyer's specifications.

Figure 39



Cutting at A instead of B yielded an additional 40 feet.

Figure 40



Right and wrong positions for limbing.

5. Leave logs of no value in the woods (cull logs), if they cannot be used for pulpwood, fuelwood, or chemical wood.

6. Prevent the log from splitting when cutting log lengths.

7. Trim all limbs close to each log.

8. Look out for metal in the logs. If you know it is there, cut it out or cut off the section containing metal.

9. If the base of the tree is hollow, taking a short log first may make the next log higher in quality. If a large hole is present at the base of the tree, cutting a long log results in loss of quality, footage and money.

10. After a few logs are cut, ask the buyer to check the logs and to show his method of scaling.

11. Standard hardwood log lengths are measured to the longest full foot. Softwood log lengths are measured in even lengths. Be sure to add trim allowance (4 inches) to these lengths.

12. Butt logs should be cut 14 to 16 feet long, if this can be done without sacrificing quality, and if you can follow buyer's specifications.

Logging Equipment

Hand Tools

Although power equipment has replaced the use of most of the hand tools in modern harvesting methods the use of the following tools are still quite popular as part of logging operations.

Axe—Axe patterns are of a great variety-largely to suit individual preference. The double-bit axe is favored by many woods workers. It has one keen blade for chopping; the other blade is less sharp for grubbing around roots or cutting hardwood. A single-bit axe is still in common use and is an efficient woods tool.

Crosscut Saws—Most crosscut saws have two types of teeth: cutting teeth which sever the fibers on each side of the cut and raker teeth which rake the shaving-like chips into the gullets between the cutting teeth and rakers and then out of the cut. The well-sharpened crosscut saw makes shavings-not sawdust.

Bow Saws—These are used both in felling trees and bucking logs up to 16 inches in diameter and commonly have blades 36 to 48 inches long. The blade is thin and this minimizes wedging. Adjustable frames maintain needed tension on the blade.

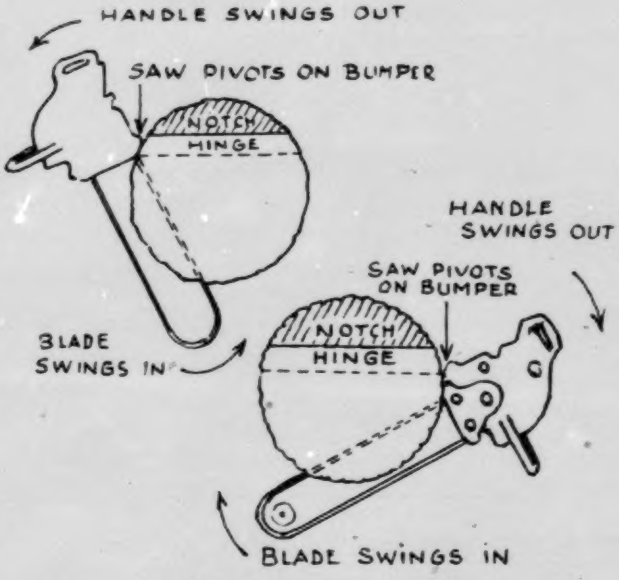
Wedges—Made of untempered steel or wood are useful for felling, bucking and splitting. They are usually 6 to 8 inches long and taper from the edge to the shank. Steel wedges should never be used behind a chain saw. Wooden wedges or wedges of some soft metal, such as aluminum, are used instead.

Cant Hook—Is helpful in rolling or prying logs and in bucking. A variation of the cant hook, called the peavey, has a steel spike in the end that can be stuck in the ground or into wood for use as a pry.

Power Tools

Power Chain Saw—Machines powered by gasoline, electricity or compressed air. Innovations and improvements are constantly being made in the saws and cutting chains. Current models have solid state ignition eliminating spark plug problems. Lightweight one-man saws for felling and bucking are commonplace among woods workers.

Figure 41



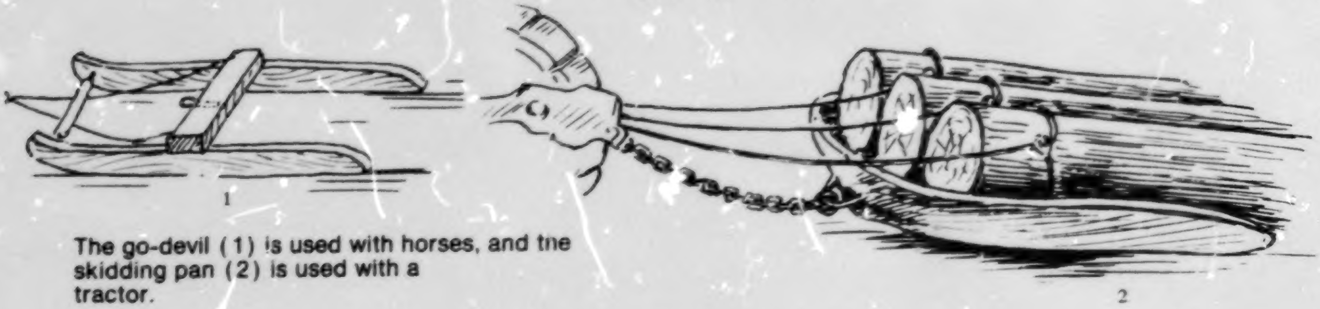
Use of a one-man chain saw in felling.
Small tree can be cut in one sweep.

Skidding Equipment

The skidding equipment needed to move products from the stump to an assembly point depends on the size, length of the product, skidding distance, lay of the land, soil conditions, season of the year and how the logs were felled.

Animals or machines supply the power needed to move the products from the stump to skidding terminal - skidway, landing or the assembly point, Often a horse can handle small products economically over short distances of several hundred feet. Large material and longer hauls

Figure 42



The go-devil (1) is used with horses, and the skidding pan (2) is used with a tractor.

require a team or small four wheel skidding or crawler tractors. By reason of their maneuverability, adaptability to a wide range of topographic conditions and overall economy, tractors have opened new possibilities in logging on every scale. In some agricultural areas of the state, farm-type wheel tractors have been used successfully in skidding small material such as pulpwood, poles and small logs.

For heavy logging, the crawler or four wheel skidding tractors are recommended. With suitable auxiliary equipment such as winches and arches, these machines can be adapted to any particular job.

For most farm woodlot skidding operations, the farm tractor used in conjunction with a logging chain or chain and skidding arch or tongs provides adequate mechanical equipment to do a successful job with a minimum financial investment.

Loading Equipment

The simplest loading possible is from a skidway located to permit gravity loading onto a truck or other conveyance. Two skid poles are set to permit rolling the round pieces onto a truck, wagon or sled.

Round pieces, if not too heavy, can be rolled up by hand on skids from the ground level but the job is easier with draft power and cross haul line.

The A-frame jammer also provides a relatively simple method of loading logs. It can be easily moved and requires the necessary cable, blocks and tackle. This method is worth using if there is much loading out to be done from the ground level.

Another loading device available on many farms is the front-end loader of a tractor. If logs are not excessively heavy, this tractor attachment works satisfactorily.

New wood-handling equipment, saving time, work and money, has started to serve the commercial logging industry. Equipment that can load logs or pulpwood sticks directly on self-contained pallets using hydraulics, means greater production, lower costs and less maintenance of equipment—all with a limited use of man power.

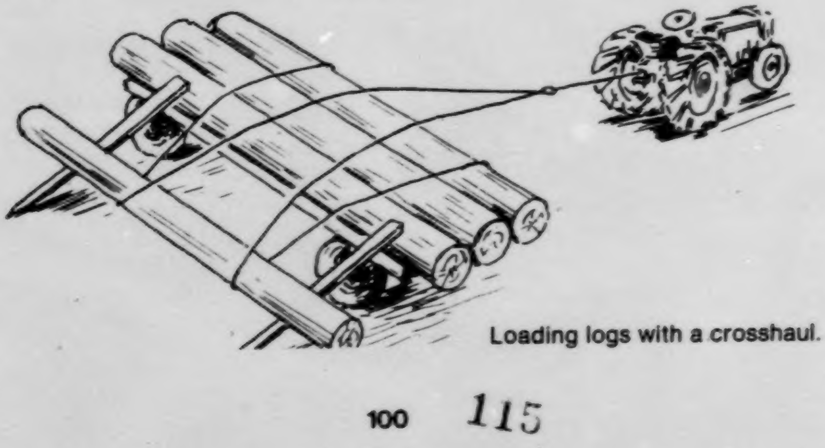
The cost of much hydraulic-powered equipment precludes use in farm woodlots and small private holdings. A hydraulic loader now used for both pulpwood and sawlogs can run into considerable capital outlay. In commercial operations, however, this cost is not excessive when reduction in man power, need for more efficient machinery and increased production are all considered.

Hauling

Wagons, trucks and sleds, depending upon the season of the year, are the usual types of conveyances for moving timber products. Trucks are generally used for long distances. The average farm wagon is not built to transport heavy logs. A tractor-trailer combination, such as might be available on some farms, is satisfactory. The load must be properly blocked, balanced and securely wrapped with chains to keep it intact during transit.

It is not ususual for an owner of a small woodland tract

Figure 43



Loading logs with a crosshaul.

to sell his forest products at the skidway or roadside and thus eliminate the loading and hauling. It hardly pays to buy special equipment and conveyances for this purpose and the usual vehicles found on the farm are often too light for hardwood sawlogs.

Processing Lumber

The operation of a farm of rural business is often made less expensive and much more convenient because of the availability of local wood products. Farmers are the country's biggest users of wood products. An individual farmer may use 100 or more fence posts and 2-3 thousand board feet of lumber annually.

A farm woodland that is large enough and managed properly can supply many of the home-needed wood products.

In order to efficiently use home-grown timber, the farmer should have a knowledge of how to convert it to useful products, its adaptability in construction, its durability and proper information on seasoning and preservation to extend its usefulness.

Custom Sawing

Scattered throughout the state are numerous custom sawmill operators. These businessmen have a self-contained portable sawmill that is mounted on rubber tires and able to come to a woodlot to saw logs. This service eliminates the need for the farmer to load and haul logs to a stationary sawmill that may be some distance away. Most custom operators saw logs all year. A minimum of two thousand feet is usually required. The farmer also must furnish several additional men to help. The farmer pays a fixed fee per thousand board feet of lumber produced. An advantage of this service is that the farmer can have his logs sawed into the dimension lumber he wants. Most custom sawyers can cut between 800-1,000 board feet per hour, depending upon the size lumber being produced.

Seasoning

Wood is seasoned to improve its suitability for the purpose it is to be used, and for weight reduction to lower shipping costs. Seasoning is accomplished by lowering the moisture content of the wood.

If lumber cannot be used within a few days after sawing, it must be properly piled to prevent warping and twisting. Much locally sawed lumber is unfit for use because of improper handling. Hardwoods are especially subject to warping and require care and time for proper piling for drying. But this work more than pays its way in quality of the product. Future timesaving and convenience also can be assured by making separate piles for different species and varying lengths.

The amount of time required to thoroughly air-dry lumber varies by species, thickness and local climatic conditions. When lumber has lost all but 15% to 20% of its moisture, it is said to be air-dry and is a stable product under average conditions in Wisconsin.

Under ideal drying conditions in late spring and summer, the minimum time required to season one-inch boards in properly built piles is as follows:

40 Days	50 Days	60 Days	70 Days	80 Days
Basswood	Aspen	Ash	Beech	Spruce
Cottonwood	Elm	Hemlock	Birch	White Oak
Pine	Maple	Hickory	Cherry	
			Red Oak	
			Black Oak	
			Walnut	

If lumber is piled in late fall or winter, the time required for air-drying may be two or three times the minimum shown above.

Piling and seasoning are unnecessary for many purposes of rough construction, provided the lumber can be used as soon as it is sawn and is not permitted to warp. Hog houses, shed, cribs and other outbuildings are commonly put up with green lumber.

Piling Lumber

The lumber should be piled immediately after sawing. There should be no delay or the wood will stain and deteriorate rapidly.

The site should be well drained and exposed to the wind. Avoid low, or damp ground, and remove all debris that would affect the ventilation.

When building the pile, the foundations must be solid and high enough to allow air to circulate freely under the pile. Allow 18-inches off the ground. The foundation should be sloped one-inch per linear foot from front to back to allow rain or snow to run off. Use blocks for the base and place heavy timbers on them to prevent the pile from sagging. Place the heaviest dimension stock on the bottom of the pile. Long boards should be on the outside, with shorter ones on the inside. No loose ends should be allowed to overhang without support and the boards should be at least one-inch apart to allow for air circulation. The pile should be built up, using only lumber of the same thickness in each layer, and pitching the front end of the pile outward or forward one-inch for each vertical foot to prevent rain and snow from entering between the boards.

The stickers used should be of equal thickness; for hardwoods, they should be one by one and one-fourth inches wide; for softwoods, they should be one by three inches wide. When piling, each sticker should be directly over the one below and each tier should be directly over a beam in the foundation. In most cases the sticker spacing required is from three to four feet. Checking of end boards can be reduced by extending the outer edge of stickers one inch beyond the ends of the boards at the front and rear of the pile. This practice will partially shade the ends and keep the rate of moisture loss nearer to that of the center of the pile. This means the outside stickers may have to be slightly wider. To reduce stain or decay, use only seasoned stickers or green stickers sawed from rot free heartwood, because stain occurs in sapwood.

Roofing is necessary to protect the pile from sun and rain, and to reduce checking and warping. Roofing can be done by laying boards of low-grade material about one-half inch apart, and placing another layer directly over the first so that the spaces between the lower boards are covered by the middle of the boards in the upper layer. Since good ventilation is necessary, the roof should be at least six inches above the top of the pile.

To insure good drainage, the roof should be sloped one-inch for each foot of length, and be projected at least two-feet out at the front and back of the pile. This will prevent water from draining down the pile.

Considerations for Safety While Managing and Harvesting Timber

Clothing

Wear clothing that will protect you from the needless scratches which might otherwise occur. Trousers should be cuffless and reasonably close-fitting around the ankles to help prevent tripping. Foot gear should be substantial, with a sole that will minimize the possibility of your slipping and falling.

Protective Equipment

A hard hat should always be worn while working in the woods. Safety glasses or ordinary glasses equipped with hardened lenses are desirable. Many serious eye injuries are caused by brush and twigs. When operating a power saw or other noisy equipment, use earplugs or ear muffs.

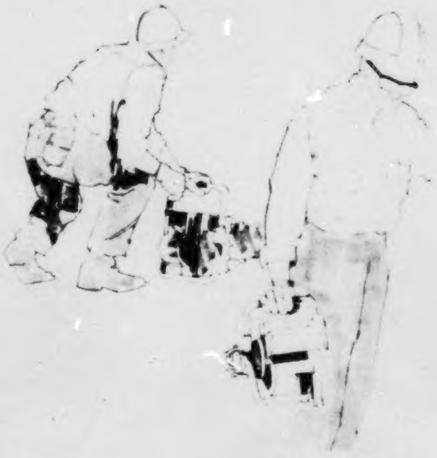
A ballistic nylon called B-64 nylon has been developed which can give the wearer a great deal of protection from accidental power saw cuts. This material is available in the form of knee pads which can be worn on the inside of the trouser leg. It also is available in some boots, where it is sewn into the instep, and gives the operator much protection in this area from power saw and axe cuts. This material has also been found to be effective in protection of legs of men trimming Christmas trees with machetes.

Buoyant vests should be worn when working in water. This lifesaving equipment should be used while in boats or on docks or other areas where one might fall into the water.

Tools

Chain saws should be operated and maintained in accordance with the manufacturer's operating instructions. Keep the chain sharp and maintain correct tension on the chain. Adjust the idling screw so the chain will stop when the motor idles. Keep fuel in an approved can. Let the motor cool before refueling. Refuel only in a cleared area. Don't smoke while refueling. Wipe spills off motor. Keep a fire extinguisher handy. Carry a chain saw with the motor stopped and the guide bar pointing to the rear. If carried on your shoulder, protect your neck with leather or heavy canvas. Never start the saw when it is on your knee. Investigate the use of a safety chain on your saw to reduce the chance of kickbacks.

Figure 44



(A) Right start -- with the saw on the ground, not the knee.

(B) Right carry -- with the saw stopped, guide bar to the rear.

The axe can be an extremely handy tool, but can also be dangerous if not properly maintained and used. Keep your axe sharp. A dull axe is an extra hazard. The head should be tight on the handle. Cracked or slivered handles should be replaced. Keep the wedge sheathed when carrying the axe to or from the job or when transporting it.

Consider the use of wood, soft metal, or plastic wedges rather than steel because they will not produce the flying steel particles such as will develop on a mushroomed head of a steel wedge.

Injector tools should be sheathed or otherwise covered while being transported and not in use.

Girdling tools should be used in accordance with the manufacturer's instructions. Safety glasses and hard hats should be worn while operating this equipment. Emergency shutoffs should be provided.

U.S. Bureau of Mines approved respirators should be used when handling chemcials requirng this protection.

Always comply with the chemical manufacturer's recommendations.

Travel

Always be alert when walking through wooded terrain and try to avoid areas where rocks could roll or dead trees could fall. If you must walk on down timber, watch out for loose bark, and, during peeling season, watch out for slippery bark in areas where peeled timber has been produced.

Try to plan your work so that you need not travel alone in wooded country. If you must, leave a written itinerary so that others will know where to look for you should you be injured or otherwise need help. Always carry with you a compass, knife, and matches in a waterproof container.

When traveling in your car, carry equipment to keep you warm in winter should the car break down. Also carry an axe, shovel, chains, and if possible, flares.

If you must travel on ice, always assume that it will not carry your weight until it is proven otherwise.

First Aid

Have a first-aid kit available for emergency treatment. If at all possible, try to get first-aid training so that in the event of an emergency, you will know how to act. Remember not to move an injured person until you have determined the extent of the injuries, unless it is imperative that he be moved to a safer area.

Treat all injuries, no matter how slight. Get tetanus shots to protect yourself from this disease.

Chemicals

All chemicals should be handled in accordance with the manufacturer's instructions. Always read carefully the instructions on the label of the container and follow them to the letter. Remember that most herbicides, insecticides, and rodenticides are very toxic substances.

Tree Felling

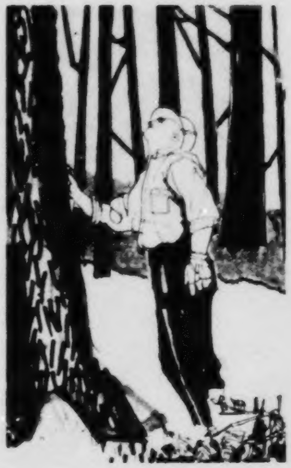
No logging operation calls for more skill, know-how and caution than the felling process! Studies and experience prove that felling and bucking are a *major* cause of frequent and severe injury!

Space yourself well away from other fallers to protect yourself and them. Don't work up-slope or down-slope from other fallers. Fell trees down-slope; never directly up-hill. Don't work during a high wind.

Size up the tree before felling. Check for lean, loose limbs, loose bark, broken tops, rot. Note the wind direction. Check the close by area for loose limbs and snags. Don't expect a nearby tree or snag to fall in the direction of a tree felled into it; the top may break off and come whizzing right at you. Scan the ground where the tree will fall, for poles or debris that might be thrown back at you.

1. Check for widowmakers. Clear brush and debris from around the tree base. Select and clear and escape path at least 25 feet to the rear of the tree and at a 45 degree angle from the direction of fall. Plan an alternate route, just in case. When working with a partner, plan in advance which direction each of you will go. Don't use chain saw to cut brush, as it will cause it to whip.

Figure 45

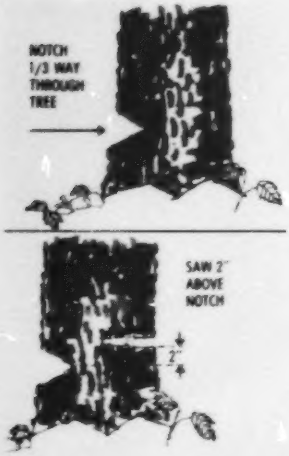


Check top for widow-makers; clear out underbrush.

2. Prepare retreat path. Make the undercut facing the direction of fall. Use good, deep undercuts, penetrating to about 1/3 the diameter of the tree. Use deeper undercuts or cornered notches for heavy-lean trees. Height of undercut opening should be at least 2 1/2 inches for each foot diameter of the tree. Clean out the back of the undercut.

3. Notch for safe fall. Sound warning before starting chain saw for back cut. Make sure everyone is in the clear. Make back cut at least 2 inches above the undercut to prevent kickback. Never cut through to the undercut. Set the saw dogs (fingers) securely so they will not clip. Stand against the saw to keep it from kicking. Watch your footing.

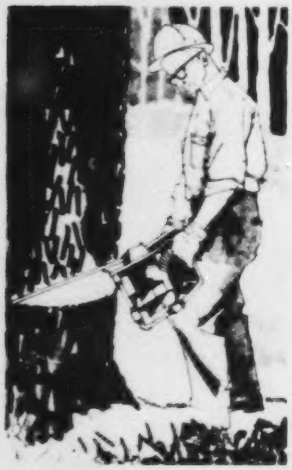
Figure 46



Notch deeply enough; saw above the notch, as detailed above.

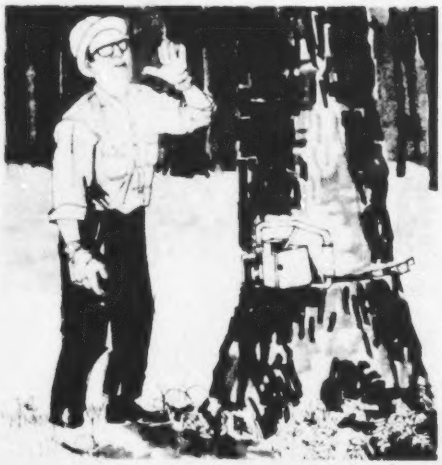
4. Get in the clear. Sound warning before completing back cut. When the cut starts to open, remove and shut off the saw, place it on the ground away from direction of fall. Retreat along escape path for at least 25 feet. Watch for flying limbs.

Figure 47



Good notching makes for safe felling.

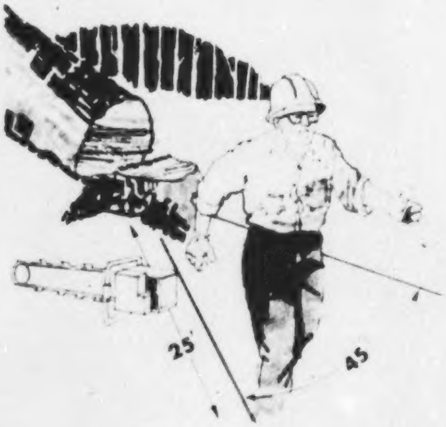
Figure 48



"Timber-r-r!" Give warning before starting felling cut . . . and again as tree starts to fall.

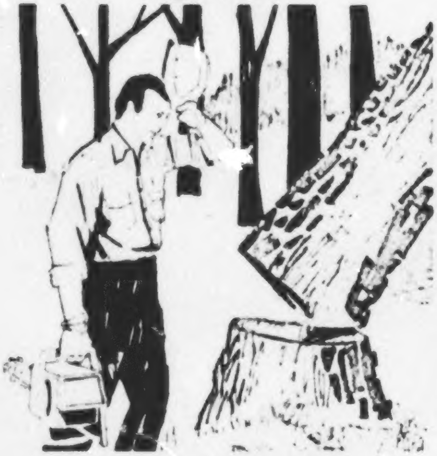
Trees don't always fall exactly as planned. If and when they are hung up, never cut down the tree supporting a hung tree, or otherwise try to saw it down. Never climb a lodged tree to shake it loose. Let the skidder pull it loose. NEVER leave a lodged tree.

Figure 49



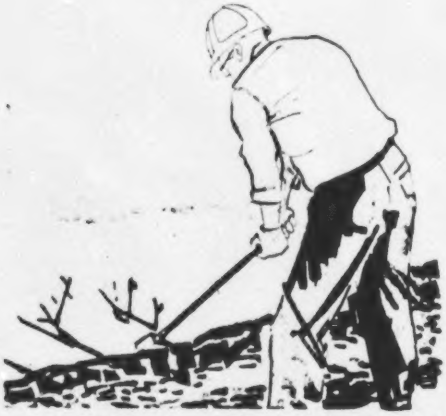
Get into the clear! Leave saw at base of tree. Retreat over cleared route at 45° angle from direction of fall, and at least 25 feet back from tree.

Figure 50



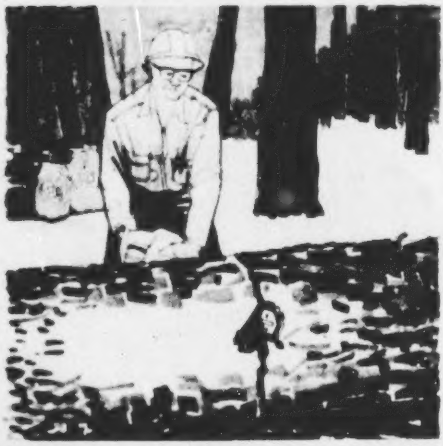
Hung tree -- and the only safe thing to do is pull it down with a tractor.

Figure 51



Limbing -- cut smaller branches with ax; stand on side opposite from where limbing is done.

Figure 52



Bucking -- work above the tree, in a cleared area with log in solid position.

Limbing and Bucking

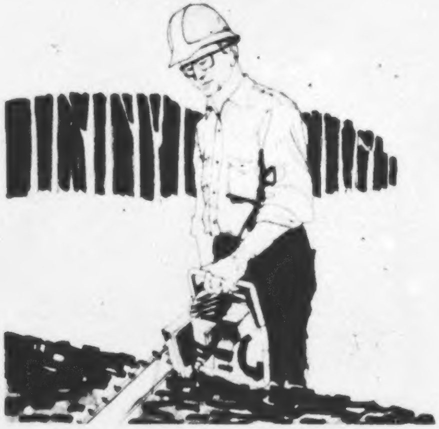
Clear a chopping and sawing area around the felled tree. Make sure footing is good. Start limbing from butt end of tree. Keep on uphill side of tree. Stand with feet in the clear and limb from opposite side if possible. Use axe on smaller limbs. Watch the spring or jump of limbs in a bind. Cut spring poles from the underside. Cut any supporting limbs last and with extreme caution — as the log may roll. When cutting large limbs, be alert for the chain saw binding and kicking back.

Clear work area and be sure you have solid footing. If necessary, block the tree to prevent rolling. Work on the uphill side; if this is impossible, have tree moved. Start the undercut first. On large logs stand against saw to avoid kicking. Watch for bind or kickback. When walking on logs, watch for loose bark. Don't jump from a log; put your saw or axe down and slide off.

In bucking windfalls, watch for binds. Choose cuts so that bind is relieved most gradually, and work from the safe side. Visualize what may happen when a root wad is bucked off, and plan accordingly with an escape path cleared before starting. Watch out for rocks and dirt that may fall from the root wad. Watch for hidden roots.

Recent studies indicate that 24 per cent of the lost time injuries in the Wisconsin logging industry take place during the tree felling process. These same injuries account for 37 per cent of the industry's compensation costs.

Figure 53



Hard hats save lives . . . and eye protection saves sight.

Skidding

Every piece of equipment used in skidding operations can be a threat to the safety of the skidder; he must know everything about the equipment, including its limitations.

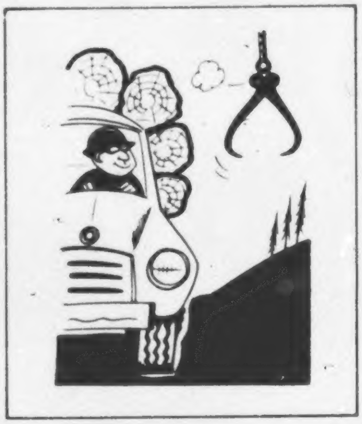
Know your signals and give them clearly. If chokers are hung up, let the operator pull them clear. Keep yourself out of reach in case they snap clear. Keep in the clear of logs that might roll, and watch out for unexpected movement of chain or choker cable. Place chokers near, but not less than 2 feet from, the log's end. Stay behind and to the side of a moving load; never ride it. Stay clear of cables under tension. Inspect cables frequently for broken strands; watch for jaggers. Wear gloves.

Know and obey signals. Use care in mounting a tractor; guard against slipping. Move tractor only when you know everyone is in the clear. Never pull a load around a sharp turn. Drop the load, make the turn, then winch the load in. Couple the load in close. Short hookups are less likely to catch on obstacles. Use caution in going up or down steep slopes, never go straight across. Don't trail the winch cable, wind it on the drum. Always operate the winch from the tractor seat. Don't raise logs when skidding upgrade, the tractor may upend. It is better to pull dead trees down with the cable, rather than push them down with the tractor. Allow no riders on the tractor or load.

Loading, Hauling and Unloading

Loader operators should be sure all crew members are clear before moving the loader. Build balanced loads. Make sure that logs are well saddled and stable before getting next log. Use special care on short peakers and crooked logs. Keep load built inside of stakes; never put logs on top of stakes. Never suspend or swing logs over crew members. If the driver or a crew member is alongside the truck, stop loading. Hold peakers in place until the first binder is in place and tightened. Lower hooks, tongs or grapple to ground when not in use.

Stay out of the space between loader and truck being loaded. Don't get between the truck cab and the log being loaded. Keep tag lines on end hooks from entagling your feet or body. Hold the end of the tag line, with slack under control. When setting hooks or tongs, keep hands from between them and the log. Keep clear of flying hooks if they cut out of the log. Stay out from between the swing of the loader and the log deck, or any other object.



After the truck is loaded, sound a warning before heaving binders over the load. Wear your hard hat. Don't back up unless you have someone to direct you. Test truck brakes before leaving the landing.

While hauling, be sure to know and obey the rules of the haul road and public highways. Watch for vehicles entering from side roads. Hold speed well within your ability to control the truck. Remember that some types of road surfaces — gravel, mud, snow — make for poor braking or stopping conditions. Check the condition of your load frequently. Check the truck regularly; especially brakes, lights, wipers, horn and emergency brakes. Remember — NO RIDERS!

Keep all binders on and tight until the unloading straps have been placed and tightened, or until a mechanical unloader is in position to prevent logs from rolling when the binders are removed. Make sure everyone is in the clear before releasing the binders, stakes or otherwise dumping the load. Use quick release binders with long trip line on unstable loads. Never go between the brow log and truck for any reason. Watch for logs swinging around or moving in the wrong direction when releasing stakes and binders. Have a plan of action in case a log rolls toward you.

Some Sources of Safety Equipment

Pagel Safety Products, Inc.
4615 National Avenue
Milwaukee, Wisconsin

Kennedy-Ingalls, Inc.
3735 North 35th Street
Milwaukee, Wisconsin

Mine Safety Appliances Company
1348 North 37th Street
Milwaukee, Wisconsin

W.A. Vorpahl and Company
1016 Velp Avenue
Green Bay, Wisconsin

Barsness and Company
304 Division
Altoona, Wisconsin

W.P. & R.S. Mars Company
Duluth, Minnesota

Bourgoin Glass Company
Waterville, Maine
(Knee pads only)

Canadian Sources of B-64 Nylon Knee Pads and B-64 Nylon Lined Boots

Collins Safety Shoes, Ltd.
255 McDonnel Street
Peterborough, Ontario, Canada

Alphide Girard, Ltd.
155 Racine East
Chicoutimi, Quebec, Canada

Insurance Coverage of Interest to the Landowner and Logging Contractor

The landowner and logging contractor should get professional advice as to the forms of insurance generally needed to protect them from lawsuits as well as to make sure they are complying with all laws concerning insurance.

Workmen's Compensation Insurance

Workmen's compensation insurance provides for payment of money and other benefits to which employees or their families are entitled by law because of occupational injury, disease or death. In Wisconsin, the law requires that anyone employing three or more employees provide this protection for his employees.

The rates for workmen's compensation insurance are established by the Wisconsin Compensation Rating Bureau.

Landowners generally require logging contractors to furnish evidence of workmen's compensation insurance before their starting to harvest timber.

General Liability Insurance

This form of insurance can be purchased to protect the landowner or timber operator from lawsuits developing because of the actual or alleged property damage or personal injury which is the result of his or his employee's negligence. It can be tailored to fit the needs of the purchaser.

Auto or Fleet Insurance

This form of insurance coverage is familiar to all of the driving public. It is wise for the landowner to make sure that anyone hauling forest products for him have the necessary fleet coverages. The timber operator who hires truckers should require the contract trucker to provide evidence of insurance.

Contractors' Equipment Floater

This form of insurance is generally purchased by the timber operator to protect him in the event of damage to his equipment (tractors, jammers, etc.) by fire, vandalism, and theft and other specified losses.

Suggested Learning Activities

Harvesting—

1. Measure trees in the timberstand and determine what products should be made from them.
2. Check the cutting operation and notice how slash is handled.
3. Demonstrate proper and safe use of the chain saw.
4. List the safety requirements under the OSHA standards for forestry.
5. Set up a display of logging tools.
6. Have a logging safety poster contest.

Marketing—

1. Write to timber buyers for specifications relating to prices of products they purchase.
2. Make up a list of local wood products and Markets.
3. Study sample timber sale agreements and contracts.
4. List wood products that can be produced from your school forest.

* * *

CHAPTER NINE

MULTIPLE USE OF FORESTS

At one time in our history, forests represented a source of much needed building material as our population expanded and moved westward to new frontiers. Little thought was given to the many other values we now recognize as very important.

After the extensive logging operations and the fires that followed it became painfully apparent that trees represented an important factor in protecting our soil and water resources especially in those areas lacking the ability to produce sufficient grown cover other than trees. This meant that many of the watersheds of our state and nation lost the stabilizing protection of tree cover. Today watershed management is an integral part of soil and water conservation.

Multiple Use

Many forests, particularly those in public ownership, are managed with different objectives in view. "Multiple use" does not imply that every acre produces many benefits. The forest as a whole, however, may do so. In some cases a single use is upper-most, in others two or more uses may receive equal attention. Under still other circumstances, there may be one main use and a secondary one.

Skillful management of multiple use forests requires careful study of the goods and services which are to be produced. In addition, possible conflicts resulting from different use of the same forest must be foreseen and resolved. The result is a plan of management which assigns to each use a place so that the total human benefit derived is as great as possible.

Watersheds

A watershed is an area of land from which rainfall or melted snow running over the surface of the land or in the ground water below the surface eventually arrive at a common point. Such waters usually flow into a stream, a river, a lake, or a reservoir. The boundaries of a watershed are defined by the high points of land which spread the flow of water, part going to one watershed, and the remainder to another.

Water is affected by the forest in three important ways. Its quality is affected by sediment or eroded soil washed down from a denuded hillside. The total amount of flow, particularly from small wooded watersheds, is reduced because trees require large amounts of water. Finally, the timing of streamflow is affected by trees on the watershed.

On steep land, particularly where the soil is easily moved by water, it is necessary that the vegetative cover be of a type that will prevent erosion. A heavy grass cover can do this. So can forest cover. The leaf and twig accumulation on the surface of the soil, that is, the forest litter, decays to form a mat or sponge called humus. This material actually absorbs large amounts of water and allows it to enter the soil slowly. If protected from grazing and burning, humus will prevent soil being washed down the slopes. Grazing, burning, or carelessly logging hillsides often result in deep gullies reaching back into the fields at the top. At the bottom of the slope, once productive fields are covered by a mass of infertile subsoil. The values which the hillsides may have had are also destroyed. Planting vegetation for the prevention of erosion is the best solution.

Trees require large quantities of water in the process of transpiration in order to live. Because their roots extend to greater depths than those of many smaller plants, they may remove soil water from deepter levels. While the removal of some of the tree cover may actually increase the water available for stream flow, total removal would seriously affect the regularity of stream flow. In Wisconsin the regularity of stream flow is more important than the total annual flow of water.

Ideally, water which is used by man would be most useful if available at a constant rate of flow throughout the year. We know that Wisconsin streams and rivers carry the greatest amount of water in April or May, when we may experience serious floods. During late summer and winter months, flows may be very low. On small watersheds where trees have an actual effect on the stream, there are clear indications that flood flows may be materially reduced and that low flows may be increased slightly. This is because some of the surface runoff after a rain is converted to ground water under forest conditions. Instead of running over the ground directly to the stream, it enters the soil and moves to the stream much more slowly as ground water.

Under some circumstances and on some land areas in Wisconsin, the most important objective for which forests can be managed is watershed protection.

Recreation

Increasing populations, a shorter working week and more leisure time, more automobiles, and a higher standard of living have resulted in an awakened interest and a tremendous increase in the desire for outdoor recreation in Wisconsin. Indications are that these will increase even more rapidly in the future. Wisconsin forests are being used more and more for such outdoor recreation. There would be little pleasure in camping, picnicking, swimming, hunting, fishing, or winter sports without our forests.

It is necessary, therefore, to make available an increasing number of forest recreation areas to meet the needs in Wisconsin. These should be provided with such essentials as drinking water, fireplaces, parking area, latrine facilities, and trash and garbage disposal units. Access should be restricted so that automobiles are not driven through the forest. Tent or trailer sites should be clearly defined.

Areas which are heavily used for recreation should be carefully planned to reduce damage to the forest as much as possible. As with grazing, there is a limited carrying capacity beyond which damage may be serious and the forest destroyed This is quite apparent in heavily used picnic or campground areas. In most forests, this kind of use may be controlled. It has been found that hunting and picnicking are the two uses most in demand in one of Wisconsin's neighboring states where more than half of the school forests are used for recreational purposes.

The more attractive portions of the forest should be selected for picnic grounds. An effort should then be made to maintain or even increase the attraction for recreational use. Long-range planning should provide as attractive surroundings as possible for future groups of people.

Picnic areas should be planned to provide facilities for groups of the size most likely to use them. Restrictions in the size of the parking lot or in the number of picnic tables will limit the number of users. This may be desirable where overuse would become a serious problem. Tables should be permanently located so they cannot be moved. This will tend to reduce damage to the area. In forests having a reasonable degree of attraction, plans should be made for heavy use even though this may not take place in the immediate future.

If lakeshore or stream banks are available, these provide ideal sites for recreational development. Scenic values are usually best in these areas, and opportunities for fishing and swimming, under suitable supervision, may be provided.

Forest Wildlife

Many species of wildlife find their home in the forest or along the brushy edges between woods and fields. Each forest region has its typical game animals and birds, and other forest creatures.

Forests provide both food and cover for many kinds of wildlife, but each species has its own special needs. A given forest community meets the needs of a certain species, but often fails to supply the wants of others. Some kinds of wildlife cause damage to growing forests, especially if their food supplies are poor or when they become too abundant. When properly managed, wildlife can be a forest crop, just as the trees are.

Let's take a look at Wisconsin's forest wildlife, and see what we can learn about wildlife problems from a school forest or nearby woodland. The kinds of wildlife that you find on your school forest, or around your home town will depend first of all on the natural forest region where you happen to live.

While it is true that logging and burning of the virgin forest destroyed the homes of many of our true northern wildlife species, the second growth forests, with their openings and brushy areas, have provided ideal food and cover for others. The deer, ruffed grouse, snowshoe hare, beaver, and coyote are among those that have found the new forests to their liking.

Bear, red fox, mink, red squirrels, and porcupines are other typical animals of the northern forest today. The sharptailed grouse and prairie chicken were once common on the cut-over areas too, but as new forests have grown up, these birds of the open lost most of their living space in the north.

Wildlife of the Hardwood Forest Region

The maple, basswood, and oak forests of the hardwood forest region are the home of the gray, red, and fox squirrels, racoon, cottontail rabbit, red and gray foxes, and in places the opossum, the deer, the ruffed grouse, and the wood duck. Pheasants nest and winter along the edges of many hardwood forests. Civilization has forced out the bear, elk, and timber wolf from most of this region because these large animals cannot be tolerated in farming areas.

Wildlife Foods in the Forest

Wildlife must have a well-balanced diet of foods that can be readily found and digested. To be a home for wildlife, the school forest must be more than just a stand of trees, It should contain the kinds of trees, shrubs, small plants, insects, and animals that the local wildlife species need.

Many wildlife food plants grow best along shrubby forest edges or in small openings in the woods. The annual harvest of timber crops in a well-managed forest helps to keep the woods in many stages of growth so that openings are always present. Woods roads, so necessary for logging, also make edge conditions where food plants can grow.

Winter is the season of food shortage for many wild creatures. For example, it is then that deer must live on the tender shoots and buds of small trees and shrubs. Good deer foods include the dogwoods, northern white-cedar, mountain maple, red maple, basswood, willow, and white pine. The twigs, of course, must be within a deer's reach. Acorns are good fall foods, but they become buried by the winter's snow.

Deer will starve if all they can find is poor food such as the white and black spruce, tamarack, alder, or hazel. When there are too many deer for their food supply the natural reproduction of young trees is prevented by overbrowsing, and planted pines may be eaten, too. Deer hunting helps to keep the herd in balance with its food supply by harvesting the annual surplus.

In winter, snowshoe hares and cottontail rabbits eat the bark and twigs of small trees and shrubs. Aspen, jack pine, and spruce are often eaten. If there are enough small trees and not too many rabbits, the future forest may only be thinned. When the rabbits become too numerous they can destroy a young forest. Your own school forest may suffer from rabbit injury in some years.

The ruffed grouse is a fine game bird that finds much of its food in small brushy forest openings, along the edges of woods, and on woods roads. Here it can find dogwood, highbush cranberry, clover and strawberry leaves, wintergreen, hawthorn, rose hips, cherries, sumac and other favorites. In winter the grouse eats the buds and catkins of aspen, hazel, and birch. A good deal can be done to encourage the ruffed grouse by harvesting mature timber and by planting forest trails to clover. Perhaps these things can be done on your own school forest to help increase the grouse crop.

The beaver is a fascinating forest animal admired for his dam building talents. Beaver feed on the bark of aspen, birch, willow, and other trees during the winter.

Most of their dams cause little trouble, but sometimes they flood valuable forests or obstruct roads and drainage ditches. When this happens, the offenders must be removed.

Porcupines are interesting fellows, too, but they feed on the bark of valuable trees. We cannot allow too many of these animals in a managed forest. Seed-eating mice and birds also cause problems when they consume most of the seed that is needed to reforest a new cutting.

Wildlife Cover

In addition to food, all living things must at times find shelter from the weather and from their natural enemies. Some also have special needs for den sites, nesting cover, or places to hide their young.

These cover needs are very important in farming areas, where the farm woodlot or shelterbelt may be the only place of refuge available. Pheasants, rabbits, and many other birds and animals seek out these places, and the edges of larger forests, for cover.

Even in the continuous forests of the evergreen forest region, cover is important. Winter snows and cold winds drive deer and grouse into thickets of balsam, spruce, cedar, or pine where there is protection. For these needs, dense stands of young trees are required, but a food supply should be nearby. The plantations of young pines or spruces on your school forest can serve as wildlife cover, especially if they have brushy edges or are adjacent to food patches.

Brush piles from pruning in plantations can furnish cover for rabbits and ruffed grouse.

Sloughs or wet areas should not be burned as they furnish excellent cover for many animals.

Suggested Learning Activities

Multiple Use

1. Set up a display of a well managed watershed.
2. Set up a display of a farm with windbreaks and shelterbelts.
3. Identidy the wildlife food plants in you forest.
4. Demonstrate water run on cultivated land vs. forested land.
5. Visit local mild or wood cutting operations.

PART III

FORESTRY LAWS
AND
FORESTRY PROGRAMS

Chapter 10: Wisconsin Forestry Laws

Appendix

Glossary

CHAPTER TEN

WISCONSIN FORESTRY LAWS

Forest Tax Law

The Wisconsin Legislature took the first step toward effecting a more equitable system of forest taxation in 1925 when it proposed a constitutional amendment to permit forest land to be taxed upon a different basis than other property. This amendment was approved by the people of the State in 1927. It was tax reform rather than a tax relief measure. The Forest Tax Law was enacted for the purpose of discouraging the destruction or premature cutting of the forest growth of the State and to encourage the growing of recurring forest crops on lands not more useful for other purposes.

This law is somewhat complex. Its main features are:

1. Official permission must be obtained to enter land under the law.
2. Entry is for a contract period of 25 or 50 years at the applicants's choice between the landowner and the State.
3. Lands eligible are entire quarter-quarter sections, fractional lots or government lots as determined by U.S. Government survey plat.
4. The owner pays an annual tax for ten-year intervals to the town. The payment from 1972-1982 is twenty cents per acre. This payment will be recalculated by the Wisconsin Department of Revenue for the next ten-year period. It may be higher or lower, depending upon the valuation of the State at the time of computation.
5. The State also pays an annual aid of 20 cents per acre to the town.
6. These taxes and aids, in lieu of real estate taxes, are distributed on a 20-40-40 basis to the county, the town and the school district in which the land is located.
7. When timber is harvested from forest crop lands, a yield tax of 10% of the value of the timber is paid.
8. The land must be open to public hunting and fishing.

Entry Requirement

Any owner of eligible land, as specified in #3 above, may file a petition with the Department of Natural Resources, prior to August 31, requesting entry of his land in the next calendar year. A public hearing is held in December to obtain evidence for the Natural Resources Board to use in accepting or rejecting an application.

Cutting Notices

Another important part of the Forest Tax Law has to do with cutting merchantable wood products from forest crop lands. The law requires the owner to file an intent-to-cut notice with the Department of Natural Resources 30 days prior to the start of cutting, specifying the amount to be cut and the volume left.

Applications for entry and additional information on this law are obtainable at your local forester's office or the Department of Natural Resources, Box 450, Madison, Wisconsin, 53701.

Woodland Tax Law

In 1953 Legislature provided a second forest tax law to complement the Forest Crop Law. This law, known as the Woodland Tax Law, was revised in 1975 to allow owners of 10 or more contiguous forest areas, but less than a quarter-quarter (usually 40 acres) or full government lot description, to enroll their property in a forestry program while paying an annual fee instead of property taxes.

Woodland Tax lands under the 1953 law remain unaffected until their enrollment expires. At that time the landowners will be given the choice of converting their contracts to the 1975 law or drop out of the program.

Upon certification, the land is entered under the Woodland Tax Law for a contract period of 15 years that runs with the land. The owner pays an annual fee (tax) of 40 cents per acre which is shared by the town, county and state.

Early withdrawal will result in a penalty provision varying from two to three times the amount of taxes that would have been paid had the land not been enrolled in the Wooodland Tax Program.

In addition, a signed forest management plan, prepared by a Department of Natural Resources Forester, is a condition of entry into the program. The forest management plan will list the practices the owner will be required to carry out in the 15 year period. The plan may be modified by the owner with consent of the Department of Natural Resources. Failure to follow the plan will result in declassification from Woodland Tax status and the payment of the penalty by the owner.

The landowner also retains full control of hunting and other public uses under the program.

Slash Disposal Law

Any person who cuts timber or other forest products within the limits of a forest protection district must dispose of all slash up to four inches in diameter resulting from such cutting within 100 feet of the center line of any public highway, railroad, or the boundary of an adjacent property owner. All slash disposal shall be by burning unless lopping or scattering is authorized by the Natural Resources Board and must not exceed one year from time of cutting.

Christmas Tree Cutting and Transportation

Cutting Christmas Trees

Before cutting Christmas trees, the landowner must file a written notice, designating the lands where the cutting will be done, with the County Clerk who will determine if any delinquent taxes are on record against the owner.

No person shall cut Christmas trees from the lands of another without the written consent of the owner, whether such lands are privately or publicly owned. Such consent shall consist of the legal description of the land where the trees were cut as well as the name of the legal owner.

Transportation

No person can ship or transport Christmas trees outside the county where they were cut without obtaining a Christmas tree dealer licesnse from the Department of Natural Resources. There is a small annual fee for such a license, obtainable from the Department of Natural Resources, Box 450, Madison, Wisconsin, 53701.

In making a shipment of Christmas trees by truck or rail, a dealer or seller must attach to the outside of the truck or car a tag or label stating his name, address and license number.

Forest Protection

The Wisconsin Statutes provide in part for the protection of the forests of the state. The Natural Resources Board is vested with power, authority and jurisdiction in all matters relating to the prevention, detection and suppression of forest fires outside the limits of incorporated cities and villages.

To provide for the protection of lands from forest fires, the Natural Resources Board has established forest protection districts to effectively carry out this responsibility.

The enforcement of laws governing the use of fire in forested areas is a significant part of the forest fire control program. Anyone who starts a fire has the responsibiltiy for keeping the fire under control. If a fire started for any purpose becomes a forest fire, liability for suppression costs shall be assessed against the person responsible.

Laws Regarding Growing, Selling and Shipping Nursery Stock

Growing Nursery Stock

Section 94.60, Wisconsin Statutes, requires a nursery license for those premises where nursery stock is produced for sales purposes. Annual nursery licenses are valid from January 1 through December 31. The graduated statutory license fee is based on the annual gross sales. An additional fee is assessed for each 25 acres or fraction thereof beyond the first 10 acres. Acreage of nursery stock produced under scattered natural self-seeded (wild) conditions is reduced at the ratio of 10 to 1 for fee assessment. Wisconsin law also requires at least one annual inspection of each growing location. When a nurseryman sells stock from a supply on hand at other than his nursery location, an additional fee is required for each such place of business. Licensed nurseries may, with no increased fee, purchase and re-sell stock from other officially inspected sources to supplement their sales.

Selling Nursery Stock

Anyone who sells or delivers nursery stock must attach a label to each package, bale or box of stock bearing the name, address and license number of the licensee and a certificate that his stock is from officially inspected sources.

Shipping Nursery Stock

It is unlawful to ship nursery stock unless it bears a certificate that it is from a licensed dealer and the stock is from officially inspected nurseries.

Timber Cutting Notices

Before any cutting of forest products to sell it is necessary that a notice of harvesting be made to the county clerk. A section of the Wisconsin Statues states that a notice in the English language giving his name and post-office address, and listing all the lands upon which such cutting is to be done, designating the same by each 40 acre government sub-division or fraction thereof with the proper, section, town, and range, by registered letter addressed to the County Clerk of each county in which the land is located. Timber cutting notices can be obtained from the County Clerks office.

Public and Private Programs

Federal Programs

Costing-sharing programs are available to the land owner for practice such as tree planting, timber stand improvement, wildlife food patches and others. New requests must be made each year. Requests must also be made before starting a practice. Payments for these programs are made through the Agricultural Stabilization and Conservation Service (ASCS). The ASCS is a federal office which administers these programs.

Private Programs

The American Forest Institute, an industry sponsored organization, in cooperation with consulting foresters, public agencies and private land owners sponsors the 33 year old American Tree Farm Program. Forest land owners can obtain management assistance from industry and public foresters. Detailed information can be obtained from any industrial or Department of Natural Resources Forester.

The American Forestry Association publishes the monthly magazine *American Forest*, which covers national and regional forest issues in a layman's language.

Wisconsin DNR Foresters

Adams
Ranger Station, Friendship 53934
Ashland
State Ranger Station, Box 220, Park Falls 54552
Barron
Courthouse, Barron 54812
Bayfield
State Ranger Station, Washburn 54891
Brown
812 S. Fisk Street, Box 3600, Green Bay 54305
Buffalo
Courthouse, Alma 54610
Burnett
Community Hall, Box 160, Webster 54893
Calumet
1003 W. College Avenue, Appleton 54911
Chippewa
Courthouse, Box 550, Chippewa Falls 54729
Clark
Courthouse, Neillsville 54456
Columbia
County Administration Bldg., Box 139, Portage 53901
Crawford
County Highway Building, Box 186, Gays Mills 54631
Dane
Southern District, Route 4, Madison 53711
Dodge
Courthouse, Jefferson 53549
Door
Courthouse, Sturgeon Bay 54235
Douglas
Ranger Station, Gordon 54838
Dunn
Courthouse, Menomonie 54751
Eau Claire
718 W. Clairemont Ave., Eau Claire 54701
Florence
Courthouse, Florence 54121
Fond du Lac
Box 2565, Oshkosh 54901
Forest
State Ranger Station, Crandon 54520
Grant
Ag. Extension Office, Fairgrounds, Route 3, Box 68A, Lancaster 53813
Green
Green Co. Ag. Bldg., Box 256, Monroe 53566
Green Lake
Courthouse, Box 308, Montello 53949
Iowa
Courthouse, Box 109, Dodgeville 53533
Iron
Ranger Station, Mercer 54547
Jackson
Box 528, Black River Falls 54615
Jefferson
Courthouse, Jefferson 53549
Juneau
Courthouse, Box 33, Mauston 53948
Kenosha
DNR, 9722 W. Watertown Plank Road, Milwaukee 53226
Kewaunee
Courthouse, Sturgeon Bay 54235
La Crosse
3550 Mormon Coulee Rd., La Crosse 54601
Lafayette
Ag. Extension Office, Fairgrounds, Box 29, Lancaster 53813
Langlade
Ranger Station, Box 48, Antigo 54409
Lincoln
Ranger Station, Merrill 54452
Manitowoc
111 1st. St., Sheboygan Falls 53085
Marathon
Courthouse, Room 2, Wausau 54401
Marinette
Industrial Parkway, Marinette 54143
Marquette
Courthouse, Box 308, Montello 53949
Menominee
Box 381, Shawano 54166
Milwaukee
DNR, 9722 W. Watertown Plank Road, Milwaukee 53226
Monroe
Courthouse, Sparta 54656
Oconto
111 Arbutus Ave., Oconto 54153
Oneida
State Ranger Station, Box 576, Rhinelander 54501
Outagamie
1003 W. College Avenue, Appleton 54911
Ozaukee
DNR, 9722 W. Watertown Plank Road, Milwaukee 53226
Pepin
Courthouse, Durand 54736
Pierce
Courthouse, Durand 54736
Polk
Agriculture Building, Balsam Lake 54810
Portage
Ranger Station, 301 Cedar St., Stevens Point 54481
Price
State Ranger Station, Box 220, Park Falls 54552
Racine
DNR, 9722 W. Watertown Plank Road, Milwaukee 53226
Richland
DNR, 250 S. Main, Box 101, Richland Center 53581
Rock
Green Co. Ag. Bldg., Box 256, Monroe 53566
Rusk
Ranger Station, Box 127, Ladysmith 54848
St. Croix
Agricultural Bldg., Box 61, Baldwin 54002
Sauk
316—5th Street, Box 138, Baraboo 53913

Sawyer
State Ranger Station, Hayward 54843
Shawano
Courthouse, Shawano 54166
Sheboygan
111 1st. St., Sheboygan Falls 53085
Taylor
Courthouse, Medford 54451
Trempealeau
Courthouse, Whitehall 54773
Vernon
Courthouse, Viroqua 54665
Vilas
Courthouse, Eagle River 54521
Walworth
DNR, 9722 W. Watertown Plank Road, Milwaukee 53226
Washburn
Ranger Station, Box 160, Spooner 54801
Washington
DNR, 9722 W. Watertown Plank Road, Milwaukee 53226
Waukesha
DNR, 9722 W. Watertown Plank Road, Milwaukee 53226
Waupaca
Courthouse Annex, Route 3, Waupaca 54981
Waushara
Ranger Station, Box 400, Wautoma 54982
Winnebago
Box 2565, Oshkosh 54901
Wood
Courthouse, Wisconsin Rapids 54494

Suggested Teaching Activities

Forestry Programs

1. Visits by local foresters to discuss:
   A. Forest crop law
   B. Cutting notices
   C. Notice of Cutting Forest Products
   D. Woodland tax law
   E. Nursery Stock laws
   F. Slash Disposal laws

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APPENDIX

Field Trips

Purposes

The purposes of field trips are numerous. A few are: (1) to introduce a unit, (2) to supplement classroom teaching, (3) to show natural phenomena in their environment, (4) to observe examples of concepts studied in the classroom, (5) to stimulate pupils' interests in the community.

Planning and Conducting the trip

1. The teacher and pupils should plan together. If possible, a committee should visit the site ahead of time; at least the teacher should do so.
2. Written permission should be obtained from the parents. Also, permission of the superintendent or principal is necessary. In high schools a trip may upset the plans of fellow teacher, so all of this must be arranged beforehand.
3. If a trip of any distance is involved, transportation must be secured. Be sure that pupils are covered by insurance; usually school buses are covered.
4. Take a first aid kit, regardless of the nature of trip.
5. Be sure to have obtained ahead of time the permission of those in authority over site to be visited.
6. Keep groups small so that everyone can see and hear.
7. Set up pupil standards of conduct and courtesy to the people and area visited as well as to each other.
8. Discuss with pupils ahead of time what to look for and what they may expect to see. Keep learning at their level.
9. Help pupils to realize the trip is for learning, although it should be enjoyable as well. The trip should not be so long as to be unduly tiring.

10 After the trip, have a class summary, exhibit, or other evaluation procedures.

11. Have group send thank-you letters to all who helped make the trip possible.

FOREST OPERATION COSTS

Date	Description of Cost and From Whom Bought	Total Paid	Operating Expenses									
			Hired Labor Paid		Custom Work and Machine Rental	Materials	Small Tools	Fuel & Oil	Repairs	Taxes	Management and Expense of Travel	Pesti-cides
			To Employees	Social Security								
	TOTALS											

FOREST WOODLAND COSTS

		Development Costs During Years From Planting to First Harvest			Capital Costs					Other Costs	
Date	Description of Cost and From Whom Bought	Real Estate Taxes	Interest on Borrowed Money	Insurance & Protection	Trees & Seedlings	Tree Planting Labor	Land Prep.	Standing Timber	Equipment and Land Purchases	Expense of Selling Trees	Trees Green Bought for Resale
	TOTAL										

INCOME

Date	Description of Sale	To Whom Sold	Retail Income	Wholesale Income	Sale of Trimmings	Trees and Greenery Bought and Resold	
	Totals						

INVENTORY OF APPRECIATION & DEPLETION ASSETS

	FIELDS OR PARTS OF FIELD (Possibly by Annual Plantings)										
	1	2	3	4	5	6	7	8	9	10	Total
1. Value at First of Year or End of last Year											
2. Development Cost— Additions During This Year											
3. Tree Account— Investments Added This Year											
4. Gross Value at Years End (Sum of lines 1, 2 and 3)											
5. Minimum Value Before Any Harvest											
6. Percent of Field Harvested This Year											
7. Depletion Allowance This Year											
8. Net Value At End of Year— (Line 4 minus line 7)											

Notes:

The summary on this page is needed to claim depletion on the income tax return.

Keep separate records on fields or parts of fields that were (1) purchased, or (2) planted at different times.

Prepare line one at the first of the year. Complete line five at the first of the year on those fields that are being harvested. All other lines are completed at the end of the year.

Line 1. This includes capital expenditures, other than land costs and costs of permanent improvements. Specifically it includes: (1) Value of standing timber on the date of purchase; (2) Cost of trees or seedlings; (3) Cost of preparing land for planting; (4) Cost of planting trees.

A producer who has elected to capitalize development expenditures and has not already treated them as annual expenditures may also include the following items during the growing period: (1) Real estate taxes; (2) Interest payments; (3) Protection costs; (4) Insurance premiums.

After this record has been kept for one year, the entry on line one for the new year will be the same as line 4 or 8 of the last year.

Line 2. Complete this at the end of the year. These costs were recorded in the expense columns headed "Development Costs...". If you capitalize your development costs, then distribute them to the appropriate field. However, if you treat development costs as annual operating expenses they must not be entered in this section.

Line 3. These costs are recorded under the section headed "Capital Costs". Distribute these to the appropriate field.

Line 4. This is the maximum capital expenditures on a field prior to the first harvest. After harvest begins, record the same value from year to year until all harvest from the field is completed, or until all field depletion is recovered on the income tax returns.

Line 5, 6, and 7. Leave blank for all growing areas not being harvested.

Line 5. This is the percent of the area harvested this year relative to the amount available just before the first harvest.

INVENTORY OF LAND, TREES, MACHINERY AND EQUIPMENT

1 Description of Property	2 Date Acquired	3 Cost or Present value (or other basis)	4 Depreciation For Prior Years	5 Method of Depreciation	6 Depreciation rate (% or life in years)	7 Depreciation This year	8 Value at Years end
Land			XXX	XXX	XXX	XXX	
Trees			XXX	XXX	XXX	XXX	
Personal Residence			XXX	XXX	XXX	XXX	
Tenant House							
Barn							
Fences							
Tractor							
Truck							
Auto							
Mower							
Tree Planting Machine							
Spray Equipment							
TOTALS							

This section provides an inventory of real estate and equipment used in tree production. It is designed similar to the Depreciation section on the Income Tax Forms described as Schedule C and Schedule F. It also provides a column for determining the inventory value at the end of the year.

The investments in land, trees, and personal residence which are shown on the first three lines are not to be reported in the depreciation section of the income tax report.

The column headed "Value at Years End" is column 3 minus column 4 and column 7.

SUMMARY OF COSTS, INVESTMENTS, AND RETURNS

Page No.		Total Paid	Operating Expenses									
			Hired Labor Paid									
			To Employees	Social Security	Custom Work & Machine Rental	Materials	Small Tools	Fuel & Oil	Repairs	Taxes	Management and Expense of Travel	Pesticides
	TOTALS											

SUMMARY OF INCOME

Page No.		Retail Income	Wholesale Income	Sale of Trimmings	
	TOTALS				

SUMMARY OF COSTS, INVESTMENT AND RETURNS

Page No.		Development Costs During Years From Planting to First Harvest			Capital Cost of Woodland				Equipment and Land Purchases	Expense of Selling Trees	Trees & Greenery Bought For Resale
		Real Estate Taxes	Interest on Borrowed Money	Insurance & Protection	Trees & Seedlings	Tree Planting Labor	Land Prep.	Standing Timber			
TOTALS											

Notes:

LABOR, EQUIPMENT, AND JOB RECORD

Date	Worker	Tractor Hours	Truck and Auto Miles		Total Labor Hours	**Hours Work by Jobs**						
						Plant	Mow	Control Pests	Trim	Cut Trees	Market	
TOTALS												

COMPARTMENT OR FIELD RECORD

Acreage									
Number trees in first planting									
Kind of trees									
Variety									
Source of trees									
Date first planting									
Date replanted									
Number replanted									
Date shearing started									
Date sheeting completed									
Date of spraying									
Date cut for harvest									
Number trees cut									
Special feature of cut trees									

Notes:

TIMBER SALE AGREEMENT

The following sample outlines many of the major items to be considered in a timber sale agreement. Additional items may have to be added to fit specific cases.

TIMBER SALE AGREEMENT

Between

Purchaser(s)	Seller(s)
____________________	____________________
____________________	____________________

I. Location of Sale Area (Legal subdivisions):

Termination Date of Sale:

Estimated Volumes and Stumpage Prices

Species	Estimated Volume	Stumpage Price

Items with (*) in front present a choice of action:

II. Trees designated for cutting:

*All trees marked by the seller or his agent with orange or yellow paint spots on tree trunk and below stump height. Stump height is fourteen inches above ground level or one-half the diameter of the stump, whichever is greater.

*All ______________ ______________inches in
(species)
diameter at stump height.

*All ______________ ______________inches in
(species)
diameter at stump height.
containing ______________100 inch pulpwood sticks to
(number)
a 4 inch top diameter.

III. Conditions of Sale:

A. The purchaser agrees to the following:

1. *It is the policy of the seller to require an initial deposit, as a bond of good faith, for all stumpage sales. This deposit consists of 10% of the total estimated stumpage value, but in no case shall the minimum deposit be less than $25.00. The deposit for this sale will amount to ______________ Payment is to be made before any cutting is started and should be made by either bank draft or money order, payable to the seller. Upon the satisfactory completion of this sale, this deposit will be refunded.

   *An advanced stumpage payment of ______________ is required before cutting starts.

2. *Stumpage payments will be based upon mill scale.

   *All products will be scaled and marked before being hauled from the woods.
3. Payment will be made on the 15th of each month for all wood products scaled the previous month, Sundays and Holidays to carry over. The check and carbon copies of the applicable scale slips shall be sent to the seller or his agent. Checks shall be payable to seller.
4. Slash disposal

   It will be the purchaser's responsibility to comply with the State laws regarding slash disposal. A copy of these regulations is attached to and is considered to be a part of this agreement.
5. The purchaser will be held liable for the full stumpage payment of all forest products destroyed by fire caused by himself or his agents - during the period covered by this sale - in the previously described sale area.
6. To protect from unnecessary injury young growth and other trees not designated for cutting.
7. To pay the penalty scale of double the stumpage rate for cutting of trees not marked or otherwise authorized for cutting.
8. To repair damage caused by logging to ditches, fences, bridges, roads, trails or other improvements damaged beyond ordinary wear and tear and to put logging roads in smooth repair upon completion of all hauling from the sale area.
9. To assume the responsibility of trespass upon lands adjacent to those described in Section I (Location of sale area).
10. Not to assign this agreement in whole or in part without the written consent of the seller.
11. Road construction and use of right-of-way must be cleared with seller or his agent.
12. Purchasers scale is basis of payment. Scale records for each separate location are to be kept separately as a matter of record.
13. Seller will *retain title to tops and other materials not considered merchantable for logs,* to dispose of as seller sees fit.
14. Purchaser will be required to furnish workmens compensation insurance and liability insurance in amount of:

    Bodily injury - $100,000 each person

    Bodily injury - $300,000 each accident

    Property damage - $50,000 each accident

    Property damage - $50,000 aggregate

    and deposit a certificate of this insurance with a 10 day notice to seller of cancellation prior to starting harvesting operations.
15. *All logs are merchantable that are not less than 8 feet long, at least 9 inches in diameter inside

bark at small end, and contain a net of (*See Below) per cent of their gross scale.

*33 1/3% Net Scale on Hardwood
*50% Net Scale on Softwood

16. *All timber included in this agreement to be paid for at unit prices shall be scaled (measured, counted or weighed). It is agreed: Saw and veneer logs shall be scaled by the Scribner Decimal C Log Rule by measuring the average diameter inside bark at the small end of the log, dropping fractional diameters of 1/2″ or less to next lower inch, and raising fractional diameters over 1/2″ to the next higher inch. A trimming allowance of 4″on sawlogs and 6″on veneer logs shall be allowed.
17. *All pulpwood included in this agreement shall be paid for on the basis of the 132 cubic foot cord; that is: 48″ wide, 48″ high and 100″ long.
18. To remove or destroy in a manner acceptable to the seller, any and all structures placed on this timber sale area for the purpose of sheltering men, animals or quipment, or for other purposes whatsoever, before the expiration of this timber sale; if the purchaser shall fail to do so, the owner may cause such removal or destruction and charge the reasonable cost to the purchaser.
19. The purchaser agrees to indemnify and save harmless the seller from and against any and all liability, demands and claims, whether well founded or otherwise, including the cost of defending the same, regardless of fault, for bodily injury to any person or damage to the property of any person whomsoever (including any employee or claimed employee of the purchaser) in any way arising out of, in the course of, and in connection with, the operations of the purchaser hereunder, and the carrying out of the terms of this sale agreement.

B. The seller agrees to the following:

1. *Notice of intention to cut.* The notice of intention to cut as required by Wisconsin law shall be filed with the county clerk by the seller.
2. To guarantee title to the forest products covered by this agreement and to defend it against all claims at his expense.
3. To allow the purchaser to use unmerchantable material from tops of trees cut for necessary logging improvements free of charge, provided such improvements are left in place by the purchaser.
4. To grant the freedom of entry and right-of-way to the purchaser and his employees on and across the area covered by this agreement and also other privileges usually extended to purchasers of stumpage which are not specifically covered, provided they do not conflict with specific provisions of this agreement.
5. *To permit tractor skidding,

IV. Cancellation of this agreement

If the purchaser fails to comply with the provisions set forth in this agreement, then upon written notice to the purchaser, this agreement will be terminated and initial deposit forfeited by the purchaser.

Signed in triplicate this ______day of ______19____

PURCHASER (s)	SELLER (s)
____________________	____________________
by________________	by________________

GLOSSARY

Forestry and Lumbering Terms

Age, planting stock. Age of planting stock from seed, with distinction between periods spent in seedling and transplant beds, as 2-0 for two-year seedlings and 2-2 for stock two years in seed and two years in transplant bed.

Age, rotation. The age at which the stand is considered ready for harvesting under the adopted plan of management.

Age, stand. The average age of the trees which compose a stand. In practice applied to even-aged stands by obtaining the average age of representative dominants.

All-aged. Applied to a stand in which theoretically trees of all ages up to and including those of the felling age are found. See also Even-aged and Uneven-aged.

Allowance for trim. Excess length of a log to allow for square-trimming the lumber to an exact length. Syn. Overlength.

Arboriculture. The care, protection and cultivation of trees primarily for shade or landscape effects.

Arch. An arch-type log-supporting device, with wheels or crawler treads, used with a tractor to facilitate skidding.

Area, annual cutting. The area necessary to cut over each year to obtain the predetermined volume of annual cut under a given plan of regulation.

Area, basal. 1) The area, usually expressed in square feet, of the cross section at breast height of a single tree or of all the trees in an acre. This is usually outside bark unless otherwise stated. 2) The area of ground surface covered by the stem or stems of a range plant, in contrast to the full spread of its herbage or foliage, usually considered at one inch above the soil.

Area, seed production. A natural or planted stand or group of stands of phenotypically superior trees, set aside, periodically rogued, and treated to stimulate seed production. The genetic quality of the trees is not known. See Orchard seed; Phenotype.

Area, virgin. An area in which there has been virtually no disturbance of the natural vegetation.

Azimuth. Direction from a point, measured in degrees clockwise from true north.

* * *

Backfire. 1) Fire set along the inner edge of a fire control line to stop a spreading wildfire by reducing the fuel or changing the direction of force of the fire's convection column. The term applies best where skilled techniques are required for successful execution. Using such fire to consume unburned fuel inside the fireline to speed up line holding and mopup is usually distinguished as "burning out" or "clean burning."

2) A prescribed fire set to burn against the wind. Also called back-burn.

3) To set a backfire.

Bar, planting. A hand tool used in making a slit-hole in which trees are planted. See Planting, forest.

Basal area. See Area, basal.

Belt, shelter. See Shelterbelt.

Blemish. In grading lumber, anything marring the appearance that is not classifiable as a "defect".

Blight. A sudden dying of shoots, foliage, or blossoms. Specific terms are sometimes applied to blights of individual parts, as leaf blight, needle blight, twig blight.

Block, burning. In prescribed burning, an area having sufficiently uniform stand and fuel conditions to be treated uniformly under a given burning prescription. The size ranges from the smallest that allows an economically acceptable cost per acre up to the largest that can conveniently be treated in one burning period.

Blow-down. See Windfall.

Board foot. See Foot, board.

Bolt. 1) A segment of a log or one sawn or split from a short log. A term usually applied to clocks from which shingles, staves and vehicle stock are manufactured. A stave bolt must contain at least three staves and must equal not more than half the round bolt from which it was split.

2) Any short log, as a pulpwood or veneer bolt.

Borer, increment. An auger-like instrument with a hollow bit, used to extract cores from trees for growth and age determination. Used also to extract wood cores for other purposes.

Breast height. See Height, breast.

Broadleaf. See Hardwoods.

Burn. An area over which fire recently has run.

Burning, controlled. The planned application of fire with intent to confine it to a predetermined area. See also Burning, prescribed.

Burning, prescribed. Skillful application of fire to natural fuels under conditions of weather, fuel moisture, soil moisture, etc., that will allow confinement of the fire to a predetermined area and at the same time will produce the intensity of heat and rate of spread required to accomplish certain planned benefits to one or more objectives of silviculture, wildlife management, grazing, hazard reduction, etc. Its objective is to employ fire scientifically to realize maximum net benefits at minimum damage and acceptable cost. See also Burning, controlled; Block, burning.

Bush, sugar. A stand mostly of sugar maple (Acer saccharum) which is currently worked for its sap. Syr Sugar grove.

Butt. The base of a tree; the larger end of a log.

Butt cut.

1) The first log above the stump. Syn. Butt log.

2) In gathering tanbark, the section of bark from the butt of a tree, usually removed before the tree is felled.

* * *

Cache, fire-tool. A supply of fire tools and equipment assembled in planned quantities or standard units at a strategic point for exclusive use in fire suppression.

Caliper (or calipers), tree. An instrument to measure diameters of trees or logs, consisting of a graduated rule with two arms, one fixed at right angles to one end of the rule, and the other sliding parallel to the fixed arm.

Cambium. A usually laterally disposed sheath of generative tissues between xylem and phloem. It gives rise to secondary xylem (wood) and phloem (inner bark).

Charcoal. A form of amorphous carbon derived from the incomplete combustion of animal or vegetable matter (e.g., bones or wood). One of the principal products of the destructive distillation of wood.

Class, age. One of the intervals into which the range of ages of vegetation is divided for classification and use.

Class, crown. A designation of trees in a forest with crowns of similar development and occupying similar positions in the crown cover. Differentiation into crown classes is intended for application in even aged stands and within the small even-aged groups in which the trees in an uneven-aged stand are often arranged. The following four crown classes are commonly recognized.

1. *Dominant.* Trees with crowns extending above the general level of the crown cover and receiving full light from above and partly from the side; larger than the average trees in the stand, and with crowns well developed but possibly somewhat crowded on the sides.
2. *Codominant.* Trees with crowns forming the general level of the crown cover and receiving full light from above, but comparatively little from the sides; usually with medium-sized crowns more or less crowded on the sides.
3. *Intermediate.* Trees shorter than those in the two preceding classes, but with crowns either below or extending into the receiving a little direct light from above, but none from the sides; usually with small crowns considerably crowded on the sides.
4. *Overtopped.* Trees with crowns entirely below the general level of the crown cover receiving no direct light either from above or from the sides. Syn. Suppressed.

Class, site. A designation of the relative productive capacity or quality of a site with reference to the species employed; the volume or the average height of dominant and codominant trees at a given age is usually used as standard for classification. Syn. Site quality.

Cleaning. An operation in a young stand, not past the sapling stage,

1) to free small trees as in plantations from weeds, vines or sod-forming grasses, and

2) to provide better growing conditions by liberating crop trees from other individuals of similar age but of less desirable species or form which are overtopping or likely to overtop them. Syn. Disengagement cutting; Weeding.

Clearcutting. An area on which the entire timber stand has been cut. See also; Cutting, methods of.

Climax. The final stage of a succession which continues to occupy an area as long as climatic or soil conditions remain unchanged.

Codominant.

1) See Class, crown.

2) In range management, any species that shares dominance with other species.

Conifer. A tree belonging to the order Coniferae, usually evergreen with cones and needle-shaped leaves, and producing wood known commercially as "softwood". See Hardwood.

Conservation. The protection, improvement, and use of natural resources according to principles that will assure their highest economic and social service.

Control, basal area. Control of the annual or periodic cut to be taken from an area of all-aged timber based upon the percentage of the total basal area represented by the oldest or mature age group.

Control, fire. All activities concerned with the protection of wild land from fire. Includes Pre-suppression. Prevention, Detection, and Suppression. See also; Fire, control of a.

Cooperage. Containers consisting of two round heads and a body composed of staves held together with hoops.

Slack. Cooperage used as containers for non-liquid products, the staves of which may be made from one or more sheets of rotary-cut veneer.

Tight. Cooperage used as containers for liquids, the numerous staves of which are snugly fitted and held tightly with hoops.

Cord. A unit of measurement of stacked wood. Common cords are: *Face*, a short cord in which the length of the pieces is one foot. *Long*, a pile of stacked wood whose largest vertical cross section contains 32 square feet, but in which the length of the pieces is greater than 4 feet. See Unit. *Short*, a pile of stacked wood whose largest vertical cross section contains 32 square feet, but in which the length of the pieces is less than 4 feet. *Standard*, a pile of stacked wood containing 128 cubic feet within its outside surfaces. The standard dimensions are 4 by 4 by 8 feet, or sticks 4 feet long, piled 4 feet high in a rick 8 feet long.

Cordwood. Wood cut in short lengths, usually measured in cords and commonly used as fuel. Applied also to other products measured in cords as chemical wood, excelsior wood, pulpwood, etc. See also Fuelwood.

Core, increment. That part of the cross section of a tree extracted by an increment borer. Used to determine age and data on growth.

Cover, crown. The canopy of green leaves and branches formed by the crowns of all trees in a forest. Syn. Leaf canopy.

Cover, forest. All trees and other woody plants in a forest.

Cover, ground. All herbaceous plants and low-growing shrubs in a forest.

Crack, frost. A longitudinal radial split in the wood of a tree, generally near the base of the bole, from internal stresses set up by low temperatures.

Crown. The branches and foliage of a tree; the upper portion of a tree.

Cruise. A survey of forest land to locate timber and estimate its quantity by species, products, size quality or other characteristics; the estimate obtained in such a survey.

Cruiser. One who cruises timber. Syn. Estimator; Land looker; Valuer.

Cull.

1) A Tree or log of merchantable size rendered unmerchantable because of poor form, limbyness, rot, or other defect.

2) The deduction from gross volume made to adjust for defect.

3) To cut a small portion of a stand by selecting one or a few of the best trees. See Forest, culled.

4) To reject a tree, log, or board in scaling or grading.

5) Any item of production which does not meet specifications.

Cut, allowable. The volume of wood which can be cut, under management, for a given period.

Cut, final. In even-aged management, the amount or volume of material removed in harvesting the main crop at the end of the rotation. See Cutting, methods of, harvest and regeneration.

Cut, harvest. The removal (in forest management) of a crop or stand of financially or physically mature trees as a final cut in even-aged management, or the removal of mature elements of a stand in uneven-aged management.

Cutting.

1) In nursery and planting practice, a portion of the stem or root of a live tree or other plant used for propagation.

2) The process of felling trees.

3) An area on which the trees have been cut or are to be cut.

Cutting, Methods of:

1. *Clearcutting.*

A. Removal of the entire stand in one cut.

B. An area on which the entire stand has been so removed.

1) *With artificial reproduction.* Reproduction after cutting obtained artificially by direct seeding or by planting.

2) *With natural reproduction.* Regeneration after cutting obtained by seeding in from the marginal stand or from trees cut in the clearing operation.

2. *Group.* See Seed-tree and Shelterwood.

3. *Harvest.* A general term for the removal of financially or physically mature trees. (In contrast to cuttings which remove immature trees.)

4. *Improvement.* A cutting made in a stand past the sapling stage for the purpose of improving its composition and character, by removing trees of less desirable species, form and condition in the main crown canopy. See Improvement, timber stand.

5. *Partial.* A cutting by which only a part of the stand is removed. It usually implies a series of such cuttings.

6. *Regeneration or Reproduction.* Any cutting intended to encourage or facilitate regeneration, or make regeneration possible.

7. *Salvage.* A cutting made to remove trees killed or injured badly to utilize merchantable material before it becomes worthless. See also Sanitation.

8. *Sanitation.* A cutting made to remove trees killed or injured by fire, insects, fungi, or other harmful agencies (and sometimes trees susceptible to such injuries), for the purpose of preventing the spread of insects or disease. See also Salvage.

9. *Seed.* See Shelterwood.

10. *Seed-tree.* Removal of the mature timber in one cut, except for a small number of seed trees left singly or in small groups. Called a "group cutting" when the seed trees are left in groups; also a "reserve cutting" when specially selected seed trees are left for growth as well as to furnish seed.

11. *Selection.* Removal of mature timber, usually the oldest or largest trees, either as single scattered trees or in small groups at relatively short intervals, commonly 5 to 20 years, repeated indefinitely, by means of which the continuous establishment of natural reproduction is encouraged and an uneven-aged stand is maintained.

12. *Selection, group.* A modification of the selection method whereby the mature timber is removed in small groups rather than by single trees.

13. *Selection, maturity.* A form of tree selection that removes trees which are biologically and financially most mature, as judged by a combination of the factors (1) mortality probability, (2) quantity and quality growth rate, and (3) carrying charge (or interest) based on current capital value. This system was devised for and is applied primarily in ponderosa pine; it ordinarily contemplates light and frequent partial cutting.

14. *Shelterwood.* Removal of the mature timber in a series of cuttings, which extend over a period of years equal usually to not more than one-quarter and often not more than one-tenth of the time required to grow the crop, by means of which the establishment of natural reproduction under the partial shelter of seed trees is encouraged. Syn. Uniform method; Compartment method. In theory the series of shelterwood cuttings is divided into three parts as follows:

A. Preparatory cuttings, which fit the stand for its regeneration by the removal of dying and defective trees and undesirable species, and prepare the seedbed and encourage seed production.

B. Seed cutting, which further opens the stand, before seeding takes place, to make available the amount of light and heat that the expected seedlings will require.

C. Removal cuttings, which gradually remove the remainder of the mature stand which after establishment of reproduction retards the development of young trees. The final cutting is the last of the removal cuttings. Group shelterwood is a modification whereby the successive cuttings spread outward from groups rather than extending uniformly over the stand. In strip shelterwood the successive cuttings are applied stripwise rather than uniformly over the area.

Cuttings, intermediate. Cuttings made in a stand between the time of its formation and its major harvest. Included are cleaning, liveration, weeding, release, thinning, improvement, salvage, and sanitation cuttings.

Cycle, cutting.

1) The planned interval between major felling operations in the same stand.

2) The planned period within which all portions of a working circle are logged in orderly sequence.

* * *

Damage, fire. The loss, expressed in money or other units, caused by fire. Includes all indirect losses, such as reduction in future values produced by the forest area, as well as direct losses of cover, improvements, wildlife, etc., killed or consumed by fire.

Damping-off. The killing of young seedlings by certain fungi that cause decay of the stem or roots.

Danger, fire. The resultant of both constant and varable factors, which affect the inception, spread and difficulty of control of fires and the damage they cause.

Deck, log.

1) A pile of logs.
2) A rollway.
3) The platform in a sawmill upon which logs are held just previous to sawing. Syn. Mill deck.

Deduction, defect. In scaling, the estimated amount of defective material that is subtracted from the gross volume to obtain the volume of sound wood.

Defect. Any irregularity or imperfection in a tree, log, piece product, or lumber that reduces the volume of sound wood or lowers its durability, strength, or utility value. Defects in lumber may result from such factors as insect or fungus attack, growth conditions and abnormalities, manufacturing or seasoning practices, etc.

Dendrology. The identification and systematic classification of trees.

Dendrometer. An instrument designed to estimate the diameters of standing trees at any given height by sighting from the ground.

Density, crown.

1) The compactness of the crown cover of the forest, dependent upon (a) the distance apart and (b) the compactness of the individual crowns.
2) A loose term combining the meanings of crown closure and shade density.
3) The compactness of individual tree crowns.

Density, stand. Density of stocking expressed in number of trees, basal area, volume, or other criteria, on a per-acre basis. See Index, stand-density.

Diameter, breast high, (or at breast height). The diameter of a tee at 4.5 feet above average ground level, except that in National Forest practice it is measured from the highest ground level. Abbreviated d.b.h. The additional abbreviations, o.b. and i.b. are used to designate whether the diameter refers to the measurement outside or inside the bark.

Diameter, top. The diameter, usually inside bark, at the top end of the uppermost log or merchantable, piece, or of any log or piece.

Dieback. The progressive dying, from the tip downward, of twigs, branches or tops.

Disposal, slash. Treatment of slash to reduce the fire hazard or for other purposes (preferred to Brush Disposal). Methods include:

1) *Broadcast burning.* Burning over a considerable area and permitting fire to spread freely with or without the use of firebreaks.
2) *Lopping and scattering.* Lopping the slash soon after logging and spreading it more or less evenly over the ground, without burning. Lopping may be done without scattering.
3) *Piling and burning.* Piling lopped slash resulting from logging and subsequently burning the individual piles.
4) *Progressive burning.* Burning the slash as it is piled.
5) *Pulling tops.* A method of slash disposal in the Southwest in which tops with limbs attached, or accumulations of slash, are dragged away from seed trees or advance growth to reduce damage in case of accidental fires.

Distribution, age class. Local occurrence of age classes, or the representation of different age classes in a forest. A normal distribution is a complete series of age classes corresponding to the rotation, such as will permit equal annual or periodic fellings for a given rotation.

Distribution, diameter. The manner in which the number of trees in a stand is distributed over diameter classes.

Dominant.

1) See Class, crown.
2) In range management, a species which characterizes the community in its larger aspects, usually preponderant either numerically or in mass effect.

Doyle. See Rule, log.

Drain. The annual or periodic loss in growing stock on commercial forest land due to volume removal through cutting, fire, or natural causes.

Duff. Forest litter and other organic debris in various stages of decomposition, on top of the mineral soil, typical of conifer forests in cool climates where rate of decomposition is slow, and where litter accumulation exceeds decay. See Floor, forest.

* * *

Ecology. The science which deals with the relation of plants and animals to their environment and to the site factors that operate in controlling their distribution and growth. See Silvics.

Economics, forest. Treats of forest management as an enterprise for realizing individual and social gains. It deals mainly with costs and returns, both financial and other, of forestry as related (1) to public policies, business conditions, and marketing practices; and (2) to the character, ownership, and operation of the forest.

Entomology, forest. The science that deals with insects in their relation to forests and forest products.

Even-aged. Applied to a stand in which relatively small age differences exist between individual trees. The maximum difference in age permitted in an even-aged stand is usually 10 to 20 years, though where the stand will not be harvested until it is 100 to 200 years old, larger differences up to 25 percent of the rotation age may be allowed.

* * *

Fire, causes of. For statistical purposes forest fires are grouped into broad cause classes. The eight general causes defined in U.S. Forest Service practice are:

1) *Campfire.* A fire that was started for cooking, or for providing light and warmth by persons camping or traveling on or near wild land. Usually exclusive of

fires started by railroad or lumbering employees in connection with their work.

2) *Debris Burning.* A fire spreading from any fire originally set for the purpose of clearing land, or for rubbish, garbage, range, stubble, or meadow burning. (This cause does not include incendiary fires, lumbering fires, or hazard reduction on rights-of-way of common-carrier railroads.)

3) *Incendiary.* A fire willfully set by anyone to burn vegetation or property not owned or controlled by him and without consent of the owner or his agent.

4) *Lightning.* A fire caused directly or indirectly by lightning.

5) *Lumbering.* A fire, except one caused by smokers, resulting from lumbering. (Lumbering includes all activities connected with the harvesting or processing of wood for use or sale. Lumbering fires include those caused by logging railroads which are not common carriers.)

6) *Railroad.* A fire resulting from maintenance of the right-of-way or operation of a common-carrier railroad.

7) *Smoker.* A fire caused by smoker's matches, or by burning tobacco in any form.

8) *Miscellaneous.* A fire of known cause that cannot be properly classified under any of the other seven standard causes.

Fire, control a. To complete control line around a fire, any spot fires therefrom, and any interior islands to be saved; burn out any unburned area adjacent to the fire side of the control lines; and cool down all hot spots that are immediate threats to the control line, until the lines can reasonably be expected to hold under foreseeable conditions.

Fire, crown. A fire which runs through the tops of living trees, brush or chaparral. Sometimes crown fires are classed as either running or independent, to distinguish the degree of independence from the surface fire.

Fire, flank. A fire set along a control line parallel to the wind and allowed to spread at right angles to it.

Fire, forest. Any fire on forest land which is not being used as a tool in forest protection or management in accordance with an authorized plan.

Fire, spot. Fire set outside the perimeter of the main fire by flying sparks or embers.

Firebreak. A natural or constructed barrier utilized to stop or check fires that may occur or to provide a control line from which to work. Sometimes called a fire lane.

Floor, forest. All dead vegetable matter on the mineral soil surface in the forest, including litter and unincorporated humus. See also Duff.

Foot, board. A unit of measurement represented by a board 1 foot long, 1 foot wide and 1 inch thick. Abbr. Ft. b.m.; or bd. ft. In finished or surfaced lumber, the board-foot measure is based on the measurement before surfacing or other finishing. In practice the working unit is 1,000 board feet. Abbr. M bd. ft.; M B.M. M.B.F.

Foot, board, log scale. Unit of measure of content of a log or run of logs, determined by means of a log rule. See Rule, log.

Foot, cord. One-eighth of a cord; that is, a pile of stacked wood 4 feet wide, 4 feet high, and 1 foot long, or its equivalent.

Forest. A plant association predominantly of trees and other woody vegetation.

Forest, community. Areas of woodland owned and operated by some local public or quasi-public agency primarily for local public benefit.

Forest, coppice. A forest consisting wholly or mainly of sprouts.

Forest, mature. A forest which has reached its age of utilization, the meaning differing with the object of management. See also Rotation.

Forest, mixed. A forest composed of trees of two or more species. In practice, usually a forest in which at least 20 percent are trees of other than the principal species.

Forest, national. A federal reservation dedicated to the production of timber, protection of watershed values, and equitable utilization and management for public benefit of all natural resources within its boundaries. In the United States the national forests are administered by the Forest Service of the United States Department of Agriculture.

Forest, overmature. A forest in which, as the result of age, growth has almost entirely ceased, and decay and deterioration have begun. See also Forest, mature.

Forest, protection. An area wholly or partly covered with woody growth, managed primarily for its beneficial effects on water, climate or soil rather than for wood or other forest products of services.

Forest, pure. A forest composed principally of trees of one species, usually to the extent of 80 percent or more by number but in special cases a percent of basal area or volume.

Forest, virgin. A mature or overmature forest growth essentially uninfluenced by human activity.

Forestation. The establishment of forest naturally or artificially upon areas where it is at present absent or insufficient. See Afforestation; Reforestation.

Forestry. The scientific management of forests for the continuous production of goods and services.

Forestry, city. The treatment of street, shade or park trees to preserve and protect their aesthetic value.

Forestry, farm. The practice of forestry on farm woodlands, generally more or less integrated with other farm operations.

Forestry, industrial. The practice of forestry to sustain a given industrial enterprise, as a sawmill, pulp mill, chemical plant, or a combination of these.

Forestry, intensive. The practice of forestry with the objective of obtaining the maximum in volume and quality of products per unit of area through the application of the best techniques of silviculture and management.

Forestry, multiple-purpose of multiple-use. The practice of forestry which combines two or more objectives, such as production of wood or wood-derivative products, forage and browse for domestic livestock, proper environmental conditions for wildlife, landscape effects, protection against floods and erosion, recreation, production and protection of water supplies, and national defense.

Forestry, protection. The practice of forestry with the primary objectives of (1) conserving water supplies; (2) maintaining desirable streamflow; (3) increasing ground water storage; (4) preventing erosion and reducing sedimentation; (5) providing high-quality water, and preventing pollution; (6) ameliorating adverse climatic conditions, especially wind.

Fraction, representative (R.F.). The relationship between map or photo distance and ground distance, expressed as a fraction (1/25,000) or often as a ratio 1:25,000 (1 inch on map = 25,000 inches on ground.) Also called scale.

Fuelwood. 1) Rough wood for use as fuel prepared from waste material such as branchwood, tops, defective or small logs, waste lumber, or from trees cut especially for the purpose and cut into lengths suited to the fire box. Often sold in cities as "cords" measuring 4 feet high, 8 feet long and one tier (from 12 inches up to 4 feet) deep. 2.) The portion of a stand less than sawlog size.

* * *

Girdle. To encircle the stem of a living tree with cuts that completely sever bark and cambium and often are carried well into the outer sapwood, for the purpose of killing the tree by preventing passage of nutrients or by introducing toxic materials. Besides girdling proper, or removal of bark and cambium in a band of appreciable width, girdling may take several forms, viz.:

1.) *Hacking or frilling.* A single line of overlapping downward axe cuts, leaving a frill into which toxic materials may be poured.

2.) *Double hacking.* Girdling by means of a double frill cut around the tree and the removal of the chips between them.

3.) *Notching.* Ringing the tree with notches cut well into the sapwood.

4.) *Stripping.* Peeling off a band of bark completely around the tree.

Grades, log. A classification of logs based on the external characteristics as indicators of the quality or value. Log grades vary with region, species, market, etc.

Growth, advance. Young trees which have become established naturally in a forest before cutting or regeneration operations are begun. Syn. Advance reproduction.

Growth, old. 1.) See Forest, virgin. 2.) In Forest Service usage, a stand consisting mainly of mature trees.

Growth, second. Forests that originate naturally after removal of a previous stand as by cutting, fire, or other cause. A loosely used term for young stands. In the logger's parlance, the smaller trees left after a cutting or residual trees available for another logging on the same area.

* * *

Habitat. 1) The unit-area of environment, practically synonymous with site. 2) The kind of place in which the plant or animal lives, such as forest habitat, grassland habitat and marsh habitat.

Hardwood. Generally, one of the botanical group of trees that have broad leaves, in contrast to the conifers; also wood produced by such trees regardless of texture.

Heartwood. The inner core of a woody stem, wholly composed of nonliving cells and usually differentiated from the outer enveloping layer (sapwood) by its darker color.

Heel-in. To store young trees prior to planting by placing them in a trench and covering the roots or rooting portions with soil.

Height, breast. The standard height, 4 1/2 feet above average ground level, at which the diameter of a standing tree is measured. Abbr. D.B.H.

Height, merchantable. The length of tree stem from the top of the stump to the top end of the last merchantable section. Usually expressed in feet or number of logs or bolts of some standard length.

Herbicide. A phytotoxic chemical used for killing or inhibiting the growth of plants.

High-grading. The removal from the stand of only the best trees.

Hook, cant. A tool like a peavey, but having a toe ring and lip at the end instead of a pike. See Peavey.

Horizon, soil. A layer of soil approximately parallel to the land surface with more or less well-defined characteristics that have been produced through the operation of soil-building processes.

1.) *A-horizon.* The upper horizon of the mineral soil, from which material has been removed by percolating waters. The horizon of eluviation. Commonly divided into a dark colored A1 horizon containing a relatively high content of organic matter, and light-colored A2 horizon of maximum leaching.

2) *B-horizon.* The horizon of deposition, to which materials have been added by percolating waters. The horizon of illuviation.

3) *C-horizon.* The weathered parent material.

Humus. The plant and animal residues of the soil, litter excluded, which are undergoing decomposition. See Layer, humus.

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Improvement, forest tree. A general term including all practices designed to produce genetically better forest trees, such as forest tree breeding, selection and protection of superior seed trees, provenance studies. See Genetics, forest, Breeding, forest tree.

Improvement, timber stand. All cuttings not a part of a major harvest felling, made during the life of a forest stand for the general purpose of improving the stand as regards composition, condition, or rate of growth. See cutting, methods of; Thinning.

Increment, current annual. The growth for a specific year.

Increment, mean annual. The total growth divided by the total age.

Increment, normal. 1) As applied to an entire forest, the growth in volume attained by a series of fully stocked stands arranged in a normal or ideal distribution of age classes. 2) as applied to a single stand, the growth in volume attained under full stocking.

Index, danger. A relative number indicating the severity of forest fire danger as determined from burning conditions and other variable factors of fire danger. See Index, burning.

Index, site. An expression of forest site quality based on the height of the dominant stand at an arbitrarily chosen age.

Injection, tree. The introduction, by pressure or simple absorption of a chemical - usually a water-soluble salt in solution - into the sapstream of a living tree. The purposes include: to kill the tree and make it unsuitable to insect attack, to prevent or control a disease or chlorosis, to color the wood prior to sawing, to loosen the bark to facilitate peeling of a freshly felled tree, or to destroy barkbeetle and woodbeetle broods. See Silvicide.

Insecticide. Any chemical used to destroy insects and other small invertebrates.

Interplant. To set young trees among existing forest growth, planted or natural; applicable also to planting land partly occupied by brush.

Intolerance. The incapacity of a tree to develop and grow in the shade of and in competition with other trees.

* * *

Land, commercial forest. Forest land bearing or capable of bearing timber of commercial character and economically available now or prospectively for commercial use and not otherwise withdrawn from such use.

Land, forest. Land bearing forest growth or land from which the forest has been removed but which shows evidence of past forest occupancy and which is not in other use. To qualify as forest, an area must: (1) be at least 100 feet wide; (2) be at least one acre in area; (3) have a sufficient number of trees to provide 10 percent crown coverage, or (4) lacking 10 percent crown coverage, be likely to remain in forest use.

Land, noncommercial forest. Forest land not qualifying as commercial forest land. Two classes of forest area are included: 1) commercially valuable forest land withdrawn from timber use for such purposes as parks, game refuges, military reservations, or reservoir protection; and 2) forest land which because of poor growing conditions or inaccessibility will not produce trees of commercial quality.

Land, nonstocked forest. Land capable of producing but generally lacking in tree growth.

Land, wild. Uncultivated land: it may or may not be maintained by the owner for its protective vegetative cover, or for wood or forage production, recreation, or wildlife.

Layer, annual. The layer of wood produced in one year; in temperate climates, synonymous with growth layer. See Ring, annual.

Layer, humus. The top portion of the soil which owes its characteristic features to its content of humus. The humus may be incorporated or unincorporated in the mineral soil.

Level, abney. A hand surveying instrument, designed to measure angles of elevation or depression.

Line, browse. The uppermost limit on trees and tall shrubs to which livestock and big game animals browse. Syn. Grazing line.

Line, control. An inclusive term for all the constructed or natural fire barriers and treated fire edge used to control a fire.

Line, fire. The part of a control line that is scraped or dug to mineral soil. Sometimes called fire trail. See Line, control.

Litter. The uppermost layer of the organic debris, composed of freshly fallen or slightly decomposed organic materials. Commonly designated by the letter L. Syn. Aoo-horizon. See Duff; Layer, humus.

Log, merchantable. A log that will yield products of sufficient value at least to cover the costs of conversion.

Lookout. 1) A person designated to detect and report forest fires from a vantage point. 2) A lookout station.

Lop. 1) To chop branches, tops, or small trees after felling so that the slash will lie close to the ground. 2) To cut the limbs from a felled tree. Syn. Top-lop; Limb.

Lumber

1) To log or to manufacture log into lumber, or both.

2) Timber sawed or split for use.

3) Timber sawed or split for use in building; that is, the manufactured product of logs.

4) The product of the saw and planning mill, not further manufactured than by resawing, and passing lengthwise through a standard planning machine, cross-cut to length, and matched.

Lumbering. The business of cutting or getting timber or logs from the forest for lumber.

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Machine, planting. Mechanical equipment which opens a hole or furrow and closes it again and firms the soil about a tree seedling which is usually inserted by hand.

Machine, transplanting. A mechanical device for transplanting seedlings.

Management, forest. The application of business methods and technical forestry principles to the operation of a forest property.

Management, sustained yield. Management of a forest property for continuous production with the aim of achieving, at the earliest practicable time, and approximate balance between net growth and harvest, either by annual or somewhat longer periods. See Yield, sustained.

Management, watershed. Application of business methods and technical principles to the handling of all the renewable resources in a watershed to assure maximum supplies of usable water, desirable waterflow, prevention and control of erosion, and the reduction of flood and sediment damages.

Management, wildlife. Application of business methods and technical principles to the handling of wildlife.

Market, log. An area within which there are sufficient transactions in the sale of logs to sawmills to establish prices.

Marking, timber. Selection and indication, usually by blaze or paint spot, of trees to be cut or retained in a cutting operation. Syn. Spotting.

Mast. Nuts collectively, such as acorns, beechnuts, chestnuts, and seeds of certain pines as longleaf and pinon, especially when considered as food for domestic livestock and deer.

Maturity. For a given species or stand, the approximate age beyond which growth falls off or decay begins to increase at a rate likely to assume economic importance.

Mensuration, forest. A science dealing with the measurement of volume, growth, and development of individual trees and stands and the determination of various products obtainable from them.

Merchantable.

1) Trees or stands of size and quality suitable for marketing and utilization. They may or may not be so located as to be accessible for logging.

2) A specific grade of southern yellow pine timbers.

3) A grade of logs on the Pacific Coast; "select merchantable" is a grade of boards and dimension stock under the standard grading and dressing rules for the West Coast Bureau of Lumber Grades and Inspection.

Milacre. A sample plot of 1/1000 acre (usually 1/10 chain square) used in reproduction or vegetation surveys.

Mortality. Death or destruction of forest trees as a result of competition, disease, insect damage, drought, wind, fire, and other factors.

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Nursery, forest tree. An area upon which young trees are grown for forest planting. May be characterized as seedling or transplant, temporary or permanent.

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Overbrowsing. Excessive use of browse usually found where there is an over-population of game. Similar to overgrazing, except that overgrazing refers to grasses and forbs, while overbrowsing refers to shrubs and trees.

Overcut. The cutting of a quantity of timber in excess of the annual or periodic cuting budget.

Overstocked. A condition of stand or forest indicating more trees than normal or full stocking would require. Dominants in such stands have narrow rings indicating suppression.

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Park. A relatively small opening of grassland in a forest.

Park, national. A federal reservation established exclusively to conserve the scenery, the natural and historic objects and the wild animals and plants within the reservation boundaries, and to provide for the enjoyment of these features in such manner as will leave them unimpared for future generations. In the United States such reservations are under the management of the National Park Service of the Department of the Interior.

Park, national historical. A federal reservation established to preserve evidence of historic events and places.

Pasture, woodland. Farm woodlands used for grazing.

Pathology, forest. The science that deals with diseases of forest trees or stands, and to the deterioration of forest products by organisms.

Peavey. A stout lever 5 to 7 feet long, fitted with a socket and spike and a curved steel hook that works on a bolt; used in handling logs, especially in river driving. Contrast Hook, cant.

pH. A notation introduced by Sorensen to designate relatively weak acidity and alkalinity, such as is encountered in soils and biological systems. Technically, the common logarithm of the reciprocal of the hydrogen-ion concentration of a system. A pH of 7.0 indicates precise neutrality, higher values indicate alkalinity, and lower values acidity.

Pile, lumber. An orderly arrangement of lumber that facilitates handling, seasoning, and storage. Commonly lumber is flat piled, so that the face of the board is horizontal, and each course or layer of boards rests upon stickers that permit air circulation below and above the course. Common methods of piling lumber are:

1) *Box.* So piling boards that the ends bear upon the front and rear stickers, which should in turn bear upon the front and rear foundation stringers. Of random-length boards, the longest are placed in the outside tiers. Boards in any tier should be of the same length if possible.

2) *Box, modified.* Same in appearance as box piling, but lumber overhangs rear stickers 18 to 24 inches; usually employed only for separate-length stock.

3) *Bulk or solid.* Piling without stickers so that boards are in contact and form a solid pile without either vertical or horizontal air spaces.

4) *Crib.* Piling boards to form a hollow triangle with their faces in contact at the corners.

5) *Cross.* In kiln drying, placing boards on the trucks so that their lengths are perpendicular to the length of the kiln.

6) *Edge or vertical.* Piling boards so that the edges lie in horizontal planes and the faces in vertical planes with stickers separating adjacent vertical courses of lumber.

7) *End.* In lumber storage, to pile lumber on end; a method frequently employed in storage sheds, both at the manufacturing plant and at the retail yards. Also used in out-of-door seasoning of 1-inch lumber in the South. Not to be confused with "end racking". In kiln drying, it signifies the placing of boards on the trucks so that their lengths parallel the kiln length.

8) *End racking.* The placing of boards on end against a support so as to form a pile in the shape of an X or an inverted V. This method is useful in obtaining rapid surface drying in air seasoning. Syn. Pole drying.

9) *Inclined.* So piling the lumber that the courses and stickers lie in inclined planes.

10) *Open.* Any method of piling in which the faces of the boards are separated in contrast to bulk or solid piling.

11) *Random-length.* Allowing the lumber to overhang the rear stickers at random, usually from careless or indifferent piling.

Pile, slash. A round or rectangular pile of slash constructed to burn completely, or nearly so, upon ignition, without further handling.

Plan, management. A written plan for the operation of a forest property using forestry principles. It usually records data and prescribes measures designed to provide for optimum use of all forest resources.

Plantation. An artificially reforested area, established by planting or by direct seeding.

Planting, forest. The process of establishing a forest by setting seedlings, young trees, or, with certain species, by planting cuttings. Sometimes loosely used to include direct seeding. Common methods of planting are:

1) *Ball.* Planting young trees with balls of earth around the roots; sometimes in paper pots.

2) *Hole.* The trees are set in a hole; to be distinguished from the slit method. Trees may be planted in the center of the hole (center-hole planting), or against the side (side-hole planting). Deep-hole planting is to accomodate long roots.

3) *Inverted V or Wedge.* A method of planting in which roots are separated on either side of a wedge of earth left in place when hole is dug.

4) *Mound.* On wet ground, the trees are set upon mounds, ridges, or hills; in dry ground, with roots spread over a cone of soil formed in the bottom of a dug hole.

5) *Pit.* The trees are set in small depressions or pits.

6) *Pot.* Planting of trees in paper pots or cans in which they have been grown or transplanted. Pot planting is more often practiced in semi-arid regions as it permits trees to be planted early and to grow in undisturbed, moist pot soil until rains occur.

7) *Repair.* Filling out fail places by replanting.

8) *Rectangular.* An arrangement in which the trees are set at the corners of successive rectangles.

9) *Slit.* A slit or cleft is made with a planting tool, the tree inserted, and the soil firmed after withdrawal of the tool.

10) *Spot.* Planting trees in spots or scalps.

11) *Trench.* Setting out the young trees for field planting or transplanting in a continuous slit or trench.

12) *Triangular.* Setting the trees out at the corners of successive triangles.

Plot, check. The untreated, control, or stand-treatment plot in an experiment.

Plot, sample. An area laid out for the purpose of experimentation or of mensuration; may be permanent or temporary. Syn. Study plot.

Plow, fire. A heavy duty, usually specialized machine, either of the share or disk type, designed soley for abusive work in the woods and used with either horses or tractors to construct firebreaks and fire lines.

Pole. A young tree 4 inches or more in diameter breast high. The maximum size of poles is usually though not invariably taken to be some diameter breast high between 8 and 12 inches. See Sapling.

Poles. Timbers in the round, usually used to support power or telephone lines.

Presuppression, fire. Activities in advance of fire occurrence to insure effective suppression action. Includes recruiting and training, planning the organization, maintaining fire equipment and fire control improvements, and procuring equipment and supplies. See also Control, fire; Prevention, fire.

Prevention, fire. Activities directed at reducing the number of fires that start, including public education, law enforcement, personal contact and reduction of fuel hazards. See Control fire; Presuppression, fire.

Protection, forest. The activities connected with the prevention and control of damage to living forests from fire, insects, disease and other injurious and destructive agencies. See Control, fire.

Pruning. The removal of live or dead branches from standing trees. This may be done artificially or naturally. Natural pruning results from such causes as deficiency of light, decay, snow, ice, etc. Syn. Self-pruning.

Pulpwood. Wood cut or prepared primarily for manufacture into wood pulp, for subsequent manufacture into paper, fiber board, or other products, depending largely on the species cut and the pulping process.

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Rate, growth. With reference to wood, the rate at which the wood substance has been added to the tree at any particular point; usually expressed in terms of number of rings per inch. Growth rate bears an inverse relationship to number of rings per inch. Also applies to volume, value, or other types of increase in trees or stands.

Rating, fire-danger. The process of evaluating or the numerical evaluation of current fire danger based upon integrated measurements of the principal elements, natural and human. The integration is usually accomplished by the use of a fire-danger meter.

Reaction, soil. The degree of acidity or alkalinity of the soil mass expressed in pH values or in words as follows: extremely acid, below 4.5; very strongly acid, 4.5-5.0; strongly acid, 5.1-5.5; medium acid, 5.6-6.0; slightly acid, 6.1-6.5; neutral, 6.6-7.3 (strictly 7.0); mildly alkaline, 7.4-8.0; strongly alkaline, 8.1-9.0; very strongly alkaline, over 9.1.

Reforestation. The natural or artificial restocking of an area with forest trees; most commonly used in reference to the latter. See Afforestation.

Regulation, volume. A method of controlling the annual or periodic cut from a forest on the basis of growing stock and increment, using formula and disregarding area.

Release. To free trees from competition by cutting or otherwise removing or killing nearby vegetation and branches. Usually applied to young stands. See Thinning; Cleaning.

Reproduction. The process by which a forest or range is renewed.

Artificial. Renewal by direct seeding or planting. See Reforestation.

Natural. 1) Renewal by self-sown seeds, sprouts, rhizomes, etc. Syn. Regeneration. See Cutting, methods of. 2) Seedlings or saplings of any origin. Syn. Young growth.

Reproduction, vegetative. Production of new plants by any asexual method.

Resources, natural. Those potentially useful materials, forces, capacities, and conditions provided by nature.

Restocking. Applied to an area on which the forest is being reestablished by natural means.

Right, timber. A right to standing timber, exclusive of the underlying lands.

Ring, annual. The growth layer of one year, as viewed on the cross section of a stem, branch, or root. See Layer, annual.

Ring, growth. Any growth layer as viewed on the cross section of a stem, branch, or root.

Risk. 1) In fire control, the chance of fire starting as determined by the presence and activity of causative agents. 2) A causative agent.

Road, skid. 1) A road or trail leading from the stump to the skidway or landing. 2) A road over which logs are dragged, having heavy transverse skids partially sunk in the ground, usually at intervals of about 5 feet.

Rotation. The period of years required to establish and grow timber crops to maintain maximum vigor of growth and reproduction.

Rule, log. A table showing the estimated or calculated amount of lumber which can be sawed from logs of given length and diameter; commonly divided into four groups upon the basis of derivation: (1) diagram rules, (2) formula rules, (3) rules based on actual output, and (4) hybrid rules. Common rules are:

1) *Doyle rule.* A simple formula rule used in the eastern and southern United States; it underestimates small logs and overestimates large logs.
2) *Doyle-Scribner rule.* A combination rule derived by using Doyle rule values for logs up to 28 inches in diameter and Scribner rule for logs larger than 28 inches. This rule is extensively used by private operators in the South.
3) *International rule.* A formula rule allowing 1/2-inch taper for each 4 feet of length and 1/8-inch shrinkage for each one-inch board; closely approximating the green-chain lumber tally, in one form it assumes a 1/8-inch kerf; in modified form in which it assumes a 1/4-inch kerf, it is an official rule of the U.S. Forest Service.
4) *Scribner rule.* A diagram rule, one of the oldest in existence. It assumes 1-inch boards and 1/4-inch kerf, and makes a liberal allowance for slabs and disregards taper. Official rule in many parts of the United States.
5) *Scribner Decimal C rule.* The Scribner rule modified by rounding off the last digit to the nearest 10 and ropping the cypher. An official rule of the U.S. Forest Service.
6) *Spaulding rule.* A diagram rule, disregarding taper and allowing for an 11/32-inch saw kerf with size of slab varying with size of log. It is the statute rule for California and is widely used elsewhere on the Pacific Coast. Syn. Columbia River Rule.

Rules, grading. Specifications by which lumber is classified according to quality.

Rules, marking. Specifications by which trees are marked, either to be cut or to be left.

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Sanitation, forest. The destruction, removal, or treatment of infected or infested material for the purpose of reducing disease and insect incidence in the forest. See also Cutting, methods of.

Sap. The mositure in unseasoned wood and all that it holds in solution.

Sapling. A young tree less than 4 inches in diameter breast high. The minimum size of saplings is usually though not invariably placed at 2 inches in diameter breast high. See Pole.

Sawlog. A log large enough to produce lumber or other products that can be sawed. Its size and quality vary with the utilization practices of the region.

Sawmill. A plant at which logs are sawed into salable products. It includes all the machinery and buildings necessary for the operation of the plant.

Sawtimber. Trees that yield logs suitable in size and quality for the production of lumber.

Scale 1) The estimated sound contents in terms of a given log rule of a log or group of logs. 2) To estimate the sound contents of a log or group of logs. See Rule, log. 3) In aerial photography, See Fraction, representative.

Scale, log. The lumber contents of a log, or of a number of logs considered collectively, based on a specific log rule. See Rule. log.

Scalping, In tree planting, removal of sod or other vegetation, before or at the time of planting, form any spot or "scalp" to reduce competition with the tree.

Scarify. 1) To break up the forest floor and top soil preparatory to natural regeration or direct seeding. 2) As applied to see, to wear down by abrasion or by acid treatment an outer more or less impervious seed coat to facilitate or hasten germination.

Section. A standard subdivision of area used in United States Land Office surveys, intended to be one mile square.

Seedbed. 1) In natural regeneration, the soil or forest floor on which seed falls. 2) In nursery practice a prepared area in which seed is sown.

Seeding. A method of establishing a forest artificially by sowing seed. In broadcast seeding seed is sown over the entire area. Partial seeding may be done in strips, furrows or trenches, plots or spots.

Seedling. 1) A tree grown from seed; generally used for a young tree before it reaches the sapling stage. 2) In nursery practice, a tree that has not been transplanted in the nursery.

Seed-tree. A tree that produces seed; usually trees reserved in cutting operation to supply seed. See also Cutting, methods of.

Shelterbelt. A wind barrier of living trees and shrubs maintained for the purpose of protecting farm fields. As applied to individual farmsteads, termed "Windbreak". Syn. Belt.

Basic. In the Great Plains, a shelterbelt of sufficient width to develop forest conditions and serve as a bulwark in a protection plan.

Intermediate. In the Great Plains, a narrow shelterbelt established to supplement a basic shelterbelt. Syn. Buffer strip.

Shelterwood. See Cutting, methods of.

Silvicide. Any chemical capable of killing trees, usually by contact as by spraying or by injection. See Injection, tree; Herbicide.

Silvics. The life history and general characteristics of forest trees and stands, with particular reference to environmental factors. See Ecology.

Silvicultural system. See Cutting, methods of.

Silviculture. The art of producing and tending a forest; the application of the knowledge of silvics in the treatment of a forest; the theory and practice of controlling forest establishment, composition, and growth. See also Cutting, methods of; Thinning.

Site. An area, considered as to its ecological factors with reference to capability to produce forests or other vegetation; the combination of biotic, climatic, and soil conditions of an area.

Skid. 1) To pull logs from the stump to the skidway, landing, or mill. 2) As applied to a road, to reinforce by placing logs or poles across it, as on a corduroy road or skid road.

Slash. Debris left after logging, pruning, thinning, or brush cutting; also, large accumulation of debris after wind or fire. It includes logs chunks, bark, branches, stumps and broken understory trees or brush.

Softwood. Generally, one of the botanical groups of trees that in most cases have needle or scale-like leaves; the conifers; also, the wood produced by such trees.

Soil. The top layer of the earth's surface, composed of finely divided disintegrated rock containing more or less organic material, which is penetrated by the roots of plants. It includes the surface soil (horizon A), the subsoil (horizon B) and the upper portion of the substratum (horizon C) to the extent that it is penetrated by plant and tree roots.

Soil, acid. A soil having a preponderance of hydrogen ions over hydroxyl ions in the soil solution; thus a soil giving an acid reaction (precisely below pH 7.0; practically, below pH 6.6)

Soil, alkaline. Any soil that is alkaline in reaction (precisely, above pH 7.0; practically, above pH 7.3).

Soil, organic. Generally, any soil the solid part of which is predominantly organic matter.

Sprout. 1) A shoot from dormant buds at the base of a tree or from an exposed root. 2) A tree that has grown from a stump or root. Syn. Shoot; Root sucker. 3) See Cutting, Methods of.

Stand. 1) An aggregation of trees or other growth occupying a specific area and sufficiently uniform in composition (species, age arrangement, and condition as to be distinguishable from the forest or other growth on adjoining areas. See Stand, timber (types of).

2) In mensuration, the amount of material on a given area, usually expressed in terms of stand per acre.

3) In wildlife, density of game acre.

4) In wildlife, place from which game is shot as it is driven past the shooter.

) Syn. Cover, range plant.

Stand, timber (types of):

1) *Fully stocked.* A forest stand in which all growing space is effectively occupied but having ample room for development of the crop trees. Syn. Normal stand.

2) *Mixed.* A stand in which less than 80 percent of the trees in the main crown canopy are of a single species.

3) *Old-field.* A stand which has taken possession of land once used for agricultural crops or for pasture.

4) *Overstocked.* A condition of overcrowding in a stand leading to retarded growth.

5) *Pole-timber.* A stand in which the bulk of the trees are of a diameter and height suitable to making poles.

6) *Pure.* A stand in which at least 80 percent of the trees in the main crown canopy are of a single species.

7) *Residual.* The stand remaining after the completion of cutting.

8) *Sawtimber.* A stand in which the bulk of the trees are of merchantable size or where the merchantable volume per acre exceeds the economic minimum.

9) Two-storied. Applied to a stand in which two height classes of considerable difference occur, the overstory and understory. The term is not applicable to a forest in process of reproduction, in which the appearance of two stories is the temporary result of an incomplete process.

10) *Understocked.* A stand in which the growing space is not effectively occupied by crop trees.

Stem. 1) The trunk of a tree. It may extend to the top of the tree as in some conifers, or it may be lost in the ramification of the crown, as in most broadleaf trees. Syn. Bole; Trunk; Shaft. 2) The principal axis of a plant from which buds and shoots are developed.

Stick, Biltmore. A rule graduated in such a way that the diameter of standing tree may be estimated when the stick is held tangent to the surface at right angles to the main axis of the tree, and at a distance from the eye for which the stick is graduated.

Stick, scale. A graduated stick for measuring the diameters and contents of logs; both measures are stamped on the stick.

Stock, planting. Seedlings, transplants, or cuttings used in planting.

Stocking.

1) An indication of the number of trees in a stand as compared to the desirable number for best growth and management, such as well-stocked, overstocked, partially stocked. See Stand, timber (types of).

2) In range management the relative intensity of animal population; ordinarily expressed in the number of acres of range allowed for each animal for a specific period, or occasionally in such relative terms as lightly, conservatively, heavily.

3) In wildlife management, density of animal populations in relation to carrying capacity.

Structure, stand. The constitution of a stand with respect to age, crown, diameter and tree classes.

Stumpage. 1) The value of timber as it stands uncut in the woods. 2) In a general sense, the standing timber itself.

Succession. The progressive development of the vegetation toward its highest ecological expression, the climax. The replacement of one plant community by another.

Primary. Plant succession on newly formed soils or upon surfaces exposed for the first time, which have never before borne vegetation.

Secondary. Plant succession which is subsequent to the destruction of part or all of the original vegetation.

Suppression, fire. All the work of extinguishing or confining a fire beginning with its discovery. See Control, fire. Methods of suppression and of crew organization are:

1) *Direct.* A method that treats the fire as a whole, or all its burning edge, by wetting, cooling, smothering, or chemically quenching the fire or by mechnaically separating the fire from unburned fuel.
2) *Flanking.* A method of attacking a fire by working along the flanks either simultaneously or successively from a less active or anchor point, and endeavoring to connect the two lines at the head.
3) *Indirect.* A method in which the control line is located along the natural fire break, favorable breaks in topography, or at considerable distance from the fire and the intervening fuel is backfired or burned out. The strip to be backfired is wider than in the parallel method and usually allows a choice of the time when the backfiring will be done.
4) *Individual-assignment.* A system of organizing men to control a fire's perimeter in which each crewman is assigned a specific section of control line where he is responsible for all suppression jobs from hotspotting to mopup.
5) *Man-passing-man.* A system of organizing men in which each crewman is assigned a specific task such as clearing or digging fire line on a specific section of the control line, and when that task is completed he passes other workers in moving to a new assignment.
6) *Parallel.* A method of suppression in which fireline is constructed approximately parallel to, and just far enough from, the fire edge to enable men and equipment to work effectively, though the line may be shortened by cutting across unburned fingers. The intervening strip of unburned fuel is normally burned out as the control line proceeds, but may be allowed to burn out unassisted where this occurs without undue delay or threat to the line.
7) *Progressive.* A system of organizing men to build fireline in which they advance without changing relative positions in line. There are two principal methods of applying the system: (1) Work is begun with a suitable space, such as 15 feet between men. Whenever one crewman overtakes another, all of those ahead move one space forward and resume work on the uncompleted part of the line. The last man does not move ahead until the work is complete in his space. Forward progress of the crew is coordinated by a crew leader. This method or organization is variously termed moveup, stepup, bumpup, and functional. (2) Each man does one to several licks or strokes of work and moves forward a specified distance. The distance is determined by the number of men equipped with a given tool and the number of licks needed per unit of line to complete the work for that tool. This method is termed one lick.

Survey, forest. An inventory of forest land to determine area, condition, timber volume, and species for specific purposes such as timber purchase, forest management, or as a basis for forest policies and programs.

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Table, stand. A summary table showing number of trees by species and diameter class for any given area.

Table, volume. A table showing for a given species the average contents of trees of given sizes in a specified unit of volume. Types of tables include:

1) *Aerial.* A volume table based upon such variables as a stand density, visible tree height, and crown diameter, which can be measured on aerial photographs. Aerial volume tables may be compiled for estimating contents of either individual trees or stands.
2) *Form class.* A volume table stating the contents of trees of different form classes and sizes.
3) *Local.* A volume table either based upon data collected from a restricted area or obtained by adapting a table of more general application to a specific locality, giving the volumes of trees based solely on diameter breast high.
4) *Regional.* A volume table based upon data collected over an extensive area and applicable to an entire region.
5) *Universal.* A volume table of general application to many species and regions.

Table, water. The upper limit of the part of the soil or underlying material wholly saturated with water.

Table, yield. A table showing for one or more given species on given sites the progressive delopment of a stand at periodic intervals covering the greater part of its useful life. It usually includes average diameter and height, basal area, number of trees, and final yields, and may include volumes of thinnings and other data. An empirical yield table is prepared for actual average stand conditions; a normal yield table is prepared for fully stocked stand conditions.

Tally, log. A record of the volume of logs estimated by log rule.

Tape, diameter. A specially graduated tape by means of which the diameter may be read directly when the tape is placed around the tree.

Taproot. The main root of a tree which strikes downward with or without heavy branching until it either reaches an impenetrable layer or one so lacking in oxygen or moisture that further downward growth is impossible.

Thinning. Cutting in an immature stand to increase its rate of growth, to foster quality growth, to improve composition, to promote sanitation, to aid in litter decomposition, to obtain greater total yield, and so recover and use material that would be lost otherwise. See also Release; Cleaning; Cutting, methods of; Improvement, timber stand. Four distinct types of thinnings are recognized, each based on a different principle in selecting tree to be removed. These are crown thinning, low thinning (thinning from below), selection thinning and quality thinning.

1) *Crown thinning.* Cutting is made principally in the upper crown classes by the removal of codominant trees that are competing strongly with the most promising individuals of these classes. Cutting in the lower crown classes is directed toward removing trees that will die and be wasted before the next cutting and is carried on only if such trees have a

positive net conversion value. Syn. Thinning from above; High thinning; Crop tree thinning.

2) *Low thinning.* Anticipates natural thinning of stand through competition, by working upward from overtopped to dominant trees, in five recognized intensities of cutting, as follows:
Grade A — light. Removes the poorest overtopped trees.
Grade B — moderate. Removes all overtopped trees and the poorer intermediate trees.
Grade C — heavy. Removes all overtopped and intermediate trees and often a few codominant trees.
Grade D — very heavy. Removes all overtopped and intermediate trees and many to most of the codominant trees. *Accretion thinning.* A cutting heavier than the D grade, removing all the codominant and few dominant trees to obtain exceptionally rapid diameter growth on reserved trees.

3) *Quality thinning.* Certain crop trees are selected in the sapling or small pole stand and at frequent intervals cuttings are made among competing trees to maintain a uniform width of annual ring to maturity.

4) *Selection thinning.* The largest dominant trees and the poorest overtopped trees, if possessing a positive net conversion value, are cut — the former to remove potential wolf trees of relatively low value and the latter to utilize these trees before they become a total loss.

Timber. A term loosely applied to forest stands or their products; often to wood in forms suitable for heavy construction as for houses, ships and bridges. Specifically, sawed lumber 5 by 5 inches or more in breadth and thickness; or, in English markets, sawed material more than 4 1/2 inches thick and 6 inches wide.

Timber, merchantable. A tree or stand of trees which may be disposed of at a profit through conversion to salable products.

Tolerance.

1) The capacity of a tree to develop and grow in the shade of and in competition with other trees.

2) In wildlife, capacity for taking doses of poison, or for withstanding poor conditions, without bad effect; degree of acceptance of a neighboring animal or species.

3) A general term for the relative ability of species to survive a deficiency of an essential growth requirement, such as light, moisture, or nutrient supply.

Transplant. 1). A tree which has been transplanted one or more times in the nursery. 2) To replant stock in the nursery to obtain more adequate development.

Tree, crop. Any tree forming or destined to form a part of the forest crop. Usually a tree selected in a young stand or plantation to be carried through maturity.

Tree, cull. Live trees of merchantable size but which are unmerchantable now or prospectively because of defects or decay.

Tree, den. A hollow tree used as a home by a mammal.

Tree, sample. A tree chosen for detailed measurement of condition, size, growth or quality.

Tree, seed. Any tree which bears seed; specifically, a tree left to provide the seed for natural reproduction. Syn. Mother tree. See cutting, methods of.

Tree, weed. A tree of a species with relatively little or no value.

Tree, wolf. A tree occupying more space than its silvicultural value warrants, curtailing better neighbors. A term usually applied to broad-crowned, short-stemmed trees.

Type, forest. A descriptive term used to group stands of similar character as regards composition and development due to certain ecological factors, by which they may be differentiated from other groups of stands. The term suggests repetition of the same character under similar conditions. A type is *temporary* if its character is due to passing influences such as logging or fire; *permanent* if no appreciable change is expected and the character is due to ecological factors alone; *climax* if it is the ultimate stage of a succession of temporary types. A *cover* type is a forest type now occupying the ground, no implication being conveyed as to whether it is temporary or permanent.

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Undercut. 1) In logging, the notch cut in a tree to govern the direction in which the tree is to fall and to prevent splitting. 2) In forest management, the harvesting of a quantity of timber less than the budgeted cut.

Underplant. To set out young trees or sow seed under an existing stand.

Understory. That portion of the trees in a forest stand below the overstory. See Stand, timber types of.

Uneven-aged. Applied to a stand in which there are considerabe differences in age of trees and in which 3 or more age classes are represented. See also All-aged.

Unit. 1) A long cord containing 160 cubic feet. Sticks are also usually cut 5 feet long as compared to 4-foot sticks in a standard cord. 2) A barrel of turpentine together with the rosin obtained in its production.

Utilization, forest. That branch of forestry concerned with the operation of harvesting and marketing the forest crop and other resources of the forest.

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Value, liquidation. The value of a forest estimated on the assumption that all the merchantable trees will be cut.

Volume. The amount of wood in a tree or stand according to some unit of measurement, (board feet, cubic feet, etc.) or some standard of use (pulpwood, sawtimber, etc.)

Volume, merchantable. The amount of wood in a tree or stand considered salable.

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Wildfire. 1) An unplanned fire requiring suppression action, as contrasted with a prescribed fire burning within prepared lines enclosing a designated area, under prescribed conditions. 2) A free-burning fire unaffected by fire suppression measures.

Wildling. A seedling naturally reproduced outside of a nursery (in contrast to a nursery-grown seedling) used in forest planting.

Windbreak. A wind barrier of living trees and shrubs maintained for the purpose of protecting the farm home, other buildings, garden, orchard or feedlots. See Shelterbelt. Syn. Farmstead windbreak; Farmstead planting.

Windfall. 1) A tree uprooted or broken off by wind. 2) An area on which the trees have been thrown by wind. Syn. Blow-down; Wind slash.

Wood. The lignified water-conducting, strengthening, and storage tissues of branches, stems and roots.

Wood, late. The denser, smaller-celled, later-formed part of a growth layer. Syn. Autumn wood; Summerwood.

Woodland, farm. The wooded portion of a farm or ranch, or the wooded land operated in connection with a farm or ranch. See Woodlot.

Woodlot.

1) A relatively restricted area devoted to the growing of farm trees; as a farm woodlot.

2) In the Northeast, a small-sized wooded tract, usually fenced. frequently grazed.

3) In the South, a shady enclosure for domestic livestock.

4) A wooded pasture.

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Year, seed. A year in which a given species produces (over a considerable area) a seed crop greatly in excess of the normal. Applied usually to trees of irregular or infrequent seed production.

Yield, sustained.

1) As applied to a policy, method of plan of forest management, implies continuous production with the aim of achieving at the earliest practicable time, an approximate balance between net growth and harvest, either by annual or somewhat longer periods.

2) As applied to forest and range management, implies measures which will maintain the productive capacity of the land.

3) As applied to a forest, refers to one which is under sustained-yield management.

4) In forest finance, refers to a forest property, the current income from which is equal to the interest on its capital value; if equality is achieved on an annual basis, the property is characterized as an annual sustained yield property; if by longer periods, as a periodic sustained yield property.

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